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FUTURE MEETINGS of the AMERICAN INSTITUTE of ELECTRICAL ENGINEERS

Place	Date	Nature	Manuscript Closing Date
Milwaukee, Wis.	March 14-16, 1932	District Meeting	(Closed)
Providence, R. I.	May 4-7, 1932	District Meeting	(Closed)
Cleveland, Ohio	June 20-24, 1932	Summer Convention	March 20, 1932
Vancouver, B. C.	Aug. 30-Sept. 2, 1932	Pacific Coast Convention	May 30, 1932
Baltimore, Md.	October 10-13, 1932	District Meeting	July 10, 1932
Memphis, Tenn.	November-1932	District Meeting	August-1932

NOTE: Members who are contemplating submitting papers for presentation at any of the above meetings should communicate promptly with Institute headquarters, 33 West 39th Street, New York, N. Y., so that such papers may be docketed for consideration by the technical program committee, which formulates programs for all meetings several months in advance. Upon receipt of this notification, Institute headquarters will mail to each prospective author important and helpful information explaining the Institute's rules relating to the preparation of manuscript and illustrations.

Future Meetings of Other Technical Organizations

Society and Nature of Meeting	Place	Date	Correspondent
Am. Physical Society	Washington, D. C.	April 28-30	W. L. Severinghaus, Secy., Columbia Univ., New York, N. Y.
Am. Railway Engg. Assn.	Chicago, Ill.	March 15-16	Am. Railway Engg. Assn., Chicago, Ill.
Am. Soc. for Testing Materials	Atlantic City, N. J.	June 20-24	Am. Soc. for Testing Matls., Philadelphia, Pa.
Am. Waterworks Assn.	Memphis, Tenn.	May 2-6	B. C. Little, Secy., 29 W. 39th St., New York, N. Y.
Electrochemical Society	Baltimore, Md.	April 20-23	C. G. Fink, Columbia Univ., New York, N. Y.
N.E.L.A. annual convention and exhibit	Atlantic City, N. J.	June 6-10	A. J. Marshall, 420 Lexington Ave., New York, N. Y.
N.E.L.A. Gt. Lakes Div. Engg. Sec.	Chicago, Ill.	April 13-14	R. J. Malcomson, 72 W. Adams St., Chicago, Ill.
N.E.L.A. New England Div. safety conf.	Boston, Mass.	April 8	Miss O. A. Bursiel, 20 Providence St., Boston, Mass.
N.E.L.A. Southeastern Div.	Old Point Comfort, Va.	April 20-22	C. M. Kilian, 508 Haas-Howell Bldg., Atlanta, Ga.
N.E.L.A. Southwestern Div.	Hot Springs, Ark.	April 25-28	S. J. Ballinger, San Antonio Pub. Serv. Co., San Antonio, Texas
N.W. Elec. Lt. & Pwr. Assn. Engg. Sec.	Portland, Ore.	April 13-15	H. H. Schoolfield, Pacific Pwr. & Lt. Co., Portland, Ore.
Soc. Ind. Engrs., Midwest	St. Louis, Mo.	April 22-23	C. C. Dent, Secy., 205 W. Wacker Dr., Chicago, Ill.
So. Am. Electrotechnical Congress	Buenos Aires, Argentina	July 4-11	R. F. Ascher, Secy., Paseo Colon 185, Buenos Aires, S. A.

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This Month—

Front Cover

Quail, Calif., repeater station on the Los Angeles-San Francisco toll cable of the Pacific Telephone & Telegraph Company, so far from inhabited centers that a complete community development is provided for those in attendance.

—— Turn to Next Page

The Power Age and Modern Civilization

Although the moving powers of heat and electricity have raised man's physical existence to Olympian heights, they have not worked similar miracles in his spiritual life. Engineers and scientists are called upon to banish fear and hatred from the human heart by application of that greatest power of all —the power of love.

By
M. I. PUPIN
Honorary Member A.I.E.E.
Columbia University
New York, N. Y.

FARADAY'S DISCOVERY of electromagnetic induction, a hundred years ago, is the closing event of a great epoch in the history of physical science and engineering. It is the epoch in which the power age was born.

Watt's invention of the steam engine marks the beginning of this epoch. It suggested to the genius of Carnot the immortal idea embodied in his well known law. This law defines what Carnot called the moving power of fire, that is of heat, a name which today is one of the greatest names in physical science.

Carnot's interpretation of the moving power of heat completed in 1824 the first great step in the evolution of the power age. The second great step was made when in 1820 Oersted discovered the magnetic force of moving electricity and a few years later Faraday discovered the electric force generated by moving magnetism. The law of action of these forces defined the moving power of electricity just as Carnot's law defined the moving power of heat. We know today that these two moving powers are the fundamental physical powers in the universe, and that their revelation was the greatest achievement ever recorded in the history of engineering sciences. It inaugurated, a hundred years ago, the power age. This age is the parent of our present civilization and the moving powers of heat and of electricity are the propelling powers in the physical evolution of this civilization.

Our civilization very often is called the machine civilization and what I call the power age often is called the age of machines. I don't like these names for the simple reason that machines are the creation of the hands of mortal man. They are transient, but the moving power of heat and the moving power of electricity are eternal; these powers are the immortal elements in the physical structure of our civilization.

Advancement of science during the power age, that is during the last hundred years, revealed that the same fundamental powers which are at work in the evolution of our civilization were also at work in the evolution of organic life ever since life appeared on this terrestrial globe and that they are also the only propelling powers in the evolution of the luminous stars. Radiations from these stars tell us that the moving powers of heat and of electricity are of celestial origin; they were brought to earth on the wings of solar radiation and remained dormant until the genius of Watt, Carnot, Oersted, Faraday, and Henry called them to the service of man. This service is the service of our central star to this tiny terrestrial globe; its mission on this earth recalls the mission of the celestial flame which, according to an ancient legend, the Titan Prometheus snatched from the radiant chariot of the sun god Helios and brought down to earth. The ancients believed that the mission of that celestial flame was to make the life of man similar to the life of the Olympian gods.

We believe that the mission of the moving powers of heat and of electricity, our most precious gifts from our central star, is to raise the life of man to Olympian heights. But has our civilization, the offspring of the power age, lived up to the lofty aim of this mission?

Two pictures occur to me when I attempt to answer that question—two entirely different pictures. In one of the pictures I see the triumphant conquest of space by the automobile and the aeronautical art. I see the wonders of power distribution increasing a hundredfold the comforts and the creative power of man, and I am thrilled by the electric waves which gliding over wires or wandering through space convey on their wings speech and melody over continents and oceans to every nook and corner of this terrestrial globe. These are a few of the miracles of our power age by which the moving powers of heat and of electricity have displayed the magic of their celestial origin; they certainly have made the physical side of human life even more glorious than the life of the Olympian gods. This achievement of the power age is its greatest glory.

But the spiritual side of human life, exhibited by another picture, is far from edifying. In this second picture we see desolation on every side in the wake of the most deadly war which the world has ever seen. The world appears here standing on the verge of economic collapse, and yet vast armies and navies are devouring the meager remnants of the wealth of nations while millions of idle workers are starving. The most repulsive figures in this horrible picture are fear and hatred, which, like two ugly demons, are hovering on each side of the boundary lines between neighboring nations.

Banish these demons from the human heart and there will be no need of vast armies and navies to guard our security against hostile neighbors; there will be no hostile neighbors, and wars will become a dying memory only of former barbarous ages. But the celestial ser-

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An address delivered by Doctor Pupin when the John Fritz Medal was presented to him at a special session of the A.I.E.E. winter convention on the evening of Jan. 27, 1932.

vants of our civilization, the moving powers of heat and of electricity, have not banished them.

Science admits that the magic of these two primordial powers cannot unaided purge the soul of man and eliminate the poisons which corrupt its spiritual life. Another moving power is sorely needed which can penetrate more deeply than the moving power of even the infinitely minute electrons into the depths of the human heart. This need was recognized nearly 2,000 years ago when our Saviour revealed the moving power in the spiritual world and commanded us to love the Lord our God, and to love our neighbors as ourselves.

This was a message of the approaching power age in the spiritual world. But this age has not yet arrived; mankind has not yet yielded to the greatest moving power in the spiritual world, and without its aid the moving powers of heat and of electricity cannot contribute their full share to the evolution of the spiritual life of man.

Love of the eternal truth and of their work to reveal this truth for the good of mankind has guided the scientists and engineers to the great triumphs of science. These triumphs of love will persuade the reluctant world that the victorious triumph of the moving power of love which Christ discovered will be the greatest triumph of the power age.

A High Speed Relay for Short Lines

A new high speed distance relay with composite impedance-reactance characteristic has been developed. This modification combines the mechanical simplicity of the impedance type relay having inherent possibilities for high speed of operation so desirable where stability is a factor, with, on the shorter lines, the greater independence of the reactance type relay from the effects of fault resistance.

By

S. L. GOLDSBOROUGH Westinghouse Elec. & Mfg. Co., Newark, N. J.
Associate A.I.E.E.

W. A. LEWIS Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Associate A.I.E.E.

TRANSMISSION of power over longer distances and the concentration of greater amounts of power over a single circuit have rendered the presence of a short circuit on the system a more serious matter, and a considerable effort therefore has been made to reduce the duration of the short circuits. The result has been the development of circuit breakers and relays operating to clear the disturbance in a very short time. The conventional type of induction overcurrent relaying, depending upon successively increasing time intervals to obtain proper selectivity between circuit breakers, is no longer suitable where the maximum speed is desired; and so a new form of relaying, known as distance relaying, has been developed for the general protection of transmission and distribution lines. Relays operating on the distance principle make use of the characteristic impedance or reactance of the circuit, as determined by comparing the voltage and current at the relaying point, to determine the distance from the relay to the fault. Hence, selectivity between circuit breakers can be obtained without the use of increasing time intervals in the time settings of relays as the generating station is approached.

The tripping-time characteristic employed with the new types of distance relays is shown in Fig. 1. When a fault occurs between station A and the point m the relay trips instantaneously. When a fault occurs between the point m and the point n, a time delay t_1 purposely is introduced in the relay at A. If the fault is between station B and the point n, the time delay introduced in the relay at A will allow the relays at B to trip the circuit breaker at B first, so the relay at A resets and does not trip its breaker. If, on the other hand, the fault is between m and B the breaker at A will be tripped after a time delay t_1. It is customary also to provide a third range of protection which will trip the circuit breaker at A after a time interval t_2, for a fault at any location between station A and the point p, if it is not cleared earlier by the action of other relay elements.

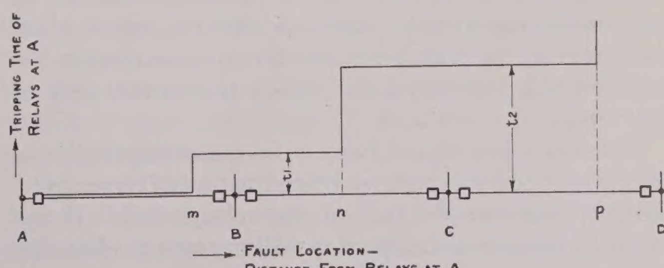


Fig. 1. Distance-time characteristic of "balance point" distance relays

Based upon "A New High Speed Distance Relay" (**No. 32M1**) presented at the A.I.E.E. winter convention, New York, N.Y., Jan. 25-29, 1932.

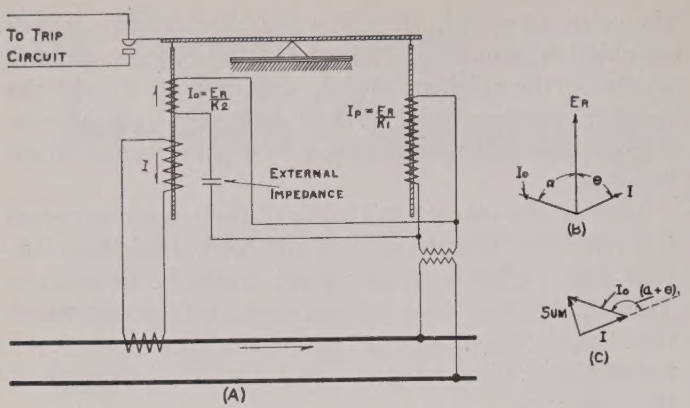


Fig. 2. Schematic diagram of new modified relay

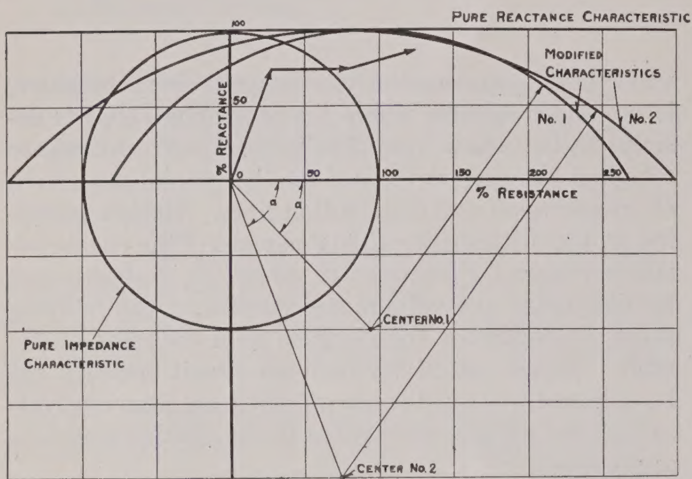


Fig. 3. Tripping characteristic of modified relay

Two general types of relays having the same time characteristics have been developed. These two types are impedance relays and reactance relays, the first of these operating on the impedance of the line between the relay and the fault, and the second on the reactance alone. Each of these types has advantages, but is subject also to certain disadvantages. The new relay described here combines the principal advantages of both of these types.

The new relay is essentially a modification of the simple balanced-beam impedance relay, as may be seen from Fig. 2. The impedance relay consists essentially of the balanced beam supporting two plungers. On one side of the relay a current coil acts to close the relay contacts and on the other side a potential coil acts to hold the contacts open. The modification, which gives the new relay its desirable characteristics, consists in the addition of a second voltage coil to the current side of the relay.

The simple impedance relay with one voltage coil and one current coil will balance when the pull of the current coil just balances the pull of the voltage coil. If the current pull increases the relay will operate to close the contacts to the trip circuit. The pull will just balance when the ratio of voltage to current is a definite constant, depending upon the design and adjustment of the relay. This constant ratio will be equal to an impedance, since impedance equals voltage divided by current. For all smaller values of impedance, the current pull will exceed the voltage pull and the relay will operate, whereas for all larger values of impedance the relay will not operate. This characteristic is shown graphically in Fig. 3 by the circle marked "pure impedance characteristic." In this figure per cent resistance is plotted along one axis and per cent reactance along the other. When the impedance is 100 per cent, the values of resistance and reactance plotted in this diagram will give a circle about the origin with 100 per cent impedance as a radius. Thus the relay trips for points lying within the circle, and does not trip for points lying outside of the circle.

The addition of the second potential coil on the current side of the relay does not change the fundamental circular characteristic of the relay, but, when plotted in the same form, has the effect of shifting the center of the circle and changing its radius. The new location of the center and the new value of the radius will depend upon the effectiveness of the second potential coil as well as on the phase angle of the current through this coil with respect to the current in the main current coil. Two such modified characteristics are shown in Fig. 3.

With the simple impedance relay, the presence of a large amount of accidental fault resistance, as may sometimes occur on relatively short lines, may cause the apparent impedance as measured by the relay to fall outside of the characteristic circle, when the impedance of the line alone, between the relay and the point of fault, would fall within the characteristic circle. For such cases the proper element of the relay would be prevented from tripping. The modified characteristics as shown in the figure greatly increase the area within which the relay will trip and thus overcome this difficulty.

A relay operating on a pure reactance characteristic, that is, one designed to trip for all values of reactance up to a given value regardless of the fault resistance, would also largely overcome this difficulty. However, the apparent reactance of high power factor loads existing before the short circuit would be very low, so that such a relay would trip under load conditions unless prevented from doing so by auxiliary devices. It is difficult to give the auxiliary devices the exact characteristics needed, and in addition some time delay is introduced by their operation, which is undesirable where high speed of fault clearing is an important factor. The modified-characteristic relay overcomes this disadvantage also because the circular characteristics intersect the resistance axis at values of resistance which will prevent operation of the relay under the heaviest loads.

The manner in which this characteristic is used to obtain the desired tripping-time characteristic illustrated in Fig. 1 is shown in Fig. 4. Three distance measuring elements are used in the complete relay, the first tripping the circuit breaker instantaneously, the second and third elements operating through an adjust-

able timer to interpose the necessary adjustable time delays t_1 and t_2. Tests have shown that arc resistance is generally quite small at the inception of the fault, but that it may increase to rather large values if the arc is allowed to persist. This indicates that in the first zone in which the relay is designed to trip instantaneously the error in distance measurement due to the effect of arc resistance will not seriously affect the operation of the relay, so that the simple impedance element may be used. However, in the second zone of the relay, such as between m and n in Fig. 1, where a definite time purposely is introduced into the operation of the relay, the arc resistance may increase to important values. Hence, on the shorter lines, the arc resistance may become large enough in comparison with the impedance of the line section to affect the operation of the relay, and the use of the modified characteristic as shown in Fig. 4 is indicated for the second distance element of the relay. The third distance element is provided for back-up protection only, and may be set to balance for faults so remote that the arc resistance will not affect its operation. Hence, a pure impedance element may likewise be used for the third element. Thus, referring to Fig. 4, for a fault between m and station B, where a time delay t_1 is required, values of fault resistance considerably in excess of the impedance of the section may be permitted without affecting the performance of the relay in any way.

The complete relay is shown in Fig. 5. In addition to the three distance elements and the timer already mentioned, there is included a sensitive directional element to insure that the relay will trip only when the fault is in the proper direction from the relay.

Mechanically the three distance measuring elements are duplicates. However, on the second element the voltage coil on the current side is provided in order to obtain the desired modified characteristic. The voltage side of each element is provided with two voltage coils, instead of the single coil indicated in Fig. 2, in order to prevent chattering and the tripping of the beam during the period when the voltage is going through zero. These two coils have separate cores but are so arranged that the beam completes the magnetic circuit in each case, and the fluxes in the two cores are shifted in phase from each other so that a practically constant voltage restraint is produced.

The timing element consists of a small floating-armature synchronous motor driven from a small saturating current transformer. The motor drives a bridging contact through suitable reduction gears so as momentarily to bridge two sets of stationary contacts which can be shifted independently on a scale in order to vary the timing. The motor normally is prevented from operating by a normally closed contact on the third or back-up distance element of the relay, which of course operates for all faults within the range of the relay. The maximum time is adjustable up to approximately 3 sec.

The directional element is of the pure wattmeter type and consists of a rectangular aluminum loop which acts as the short-circuited secondary of a small potential transformer and rides in a magnetic field produced by two current coils. Motion about the pivoted axis of the loop thus is produced and the direction of the motion is dependent upon the relative polarity of the current and voltage.

The new relay is intended for application to the shorter line sections, where the arc resistance may reach comparatively large values, for protection against line-to-line, double line-to-ground and three-phase faults. To prevent differences in the distance measurement depending upon the type of fault, the current windings

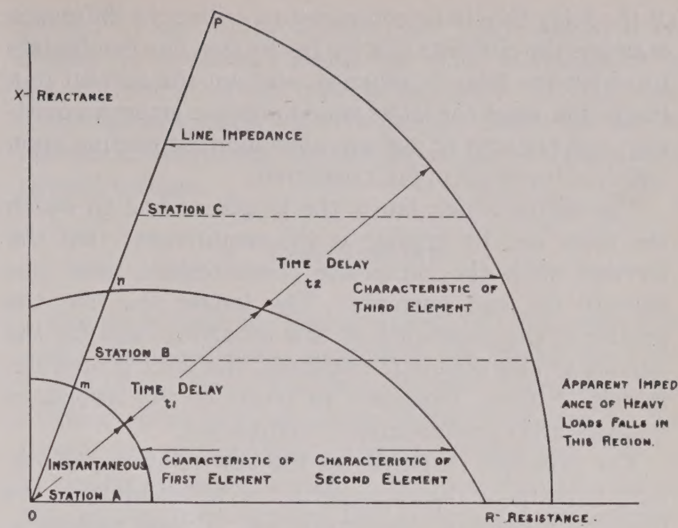


Fig. 4. Approximate characteristics of relay

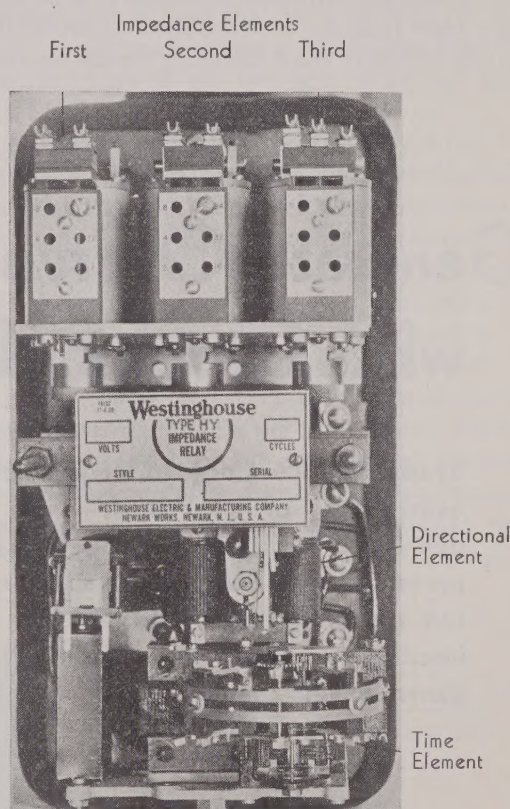


Fig. 5. New relay with modified characteristic

of the relay should be connected to utilize the difference between the currents flowing in the two line conductors to which the relay is assigned, and not the current in a single line, since the latter would produce errors amounting to 15 per cent or perhaps even more depending upon which of the types of fault occurred.

The factor which limits the length of line to which the relay can be applied is the requirement that the element with the composite characteristic must not operate on load currents. The longer the line the greater is the possibility of this occurring, and for the particular characteristic discussed, the limit is approximately 2 ohms, measured in terms of the secondary voltages and currents applied to the relay.

The principle employed in the new relay is particularly valuable in that it imparts a wide flexibility to the distance measuring characteristics. Where necessary, it can be applied to any one or all of the three elements and practically any sort of characteristic which experience may indicate to be desirable can be obtained by proper choice of characteristics for the auxiliary coil.

Generator Overvoltage when Dropping Load

Sudden dropping of load tends to result in overvoltage of generators. Tests show definitely that such overvoltage can be prevented by the use of high speed regulators and bridge type field rheostats, or by inserting resistance automatically in the generator field circuit.

By
E. J. BURNHAM
Associate A.I.E.E.

General Electric Co.,
Schenectady, N. Y.

TOTAL or partial loss of load on waterwheel-driven generators or hydroelectric stations frequently results in undesirable voltage rise, and in such cases it is desirable to limit this voltage rise in order to avoid overstressing the insulation of generators and connected apparatus.

In the past this sometimes has been accomplished by use of overvoltage, overspeed, or overfrequency relays which automatically open the field circuit and trip the generator from the line or bus when the voltage or speed reaches a predetermined value. This is a very effective way of limiting the overvoltage, but it has the disadvantage of making necessary the resynchronization of the different machines in a station, to get them back into service.

In an earlier article ("Over-Voltage on Transmission Systems Due to Dropping of Load," A.I.E.E. TRANS., 1925, V. 44, p. 872-80) was shown the manner in which under various conditions transmission line voltage will rise as a result of load dropping. The purpose of this paper is to show how the voltage on a waterwheel generator or hydroelectric station may be held within reasonable limits at a time when full load is suddenly lost, without opening the field circuits of the machines or tripping them from the line or bus.

Information given is based upon the results of tests made on a 47,000-kva. generator at the Spier Falls plant of the New York Power and Light Corporation. In these tests use was made of a newly developed high speed generator voltage regulator and a wheatstone bridge type of main exciter field rheostat which made possible the quick reduction of generator field current thereby limiting the generator voltage. Tests were made also upon the same generator to show the possibilities of limiting generator voltage by automatically inserting resistance in the alternator field.

In Fig. 1 is given a simplified diagram of the test connections used including a six-element oscillograph. The main exciter is compound wound, but as tests were desired for a shunt wound exciter, a switch was arranged to insert an 0.08-ohm resistor in the alternator field circuit to change the time constant of the circuit to a value simulating that of a shunt wound main exciter. There being no low voltage bus or circuit breaker, load always was dropped in the tests by tripping the transformer high voltage circuit breaker.

Regulator Equipment

The wheatstone bridge rheostat shown in Fig. 1 is suitable where it is desirable to reduce the main exciter voltage to a very low value or reverse it, or when the very quick reduction of exciter voltage is desirable, as in the case under consideration.

Arms marked A are operated simultaneously by motor M. Arms marked B are operated simultaneously by a handwheel to give the desired voltage reduction when the high speed relays X open. In the case under consideration a setting was made such that when relays X opened, the main exciter armature voltage was reduced to a negative value of approximately 10 volts.

The primary control element, Fig. 2, of the high speed regulator used consists of a three-phase torque motor, to the rotor of which are attached two pairs of contacts. Of these, both front and rear make contact with disks connected to a shaft driven at constant speed by a

Based upon "Overvoltage on Transmission Systems Caused by Dropping Load" (**No. 31-140**) presented at the A.I.E.E. South West District meeting, Kansas City, Mo., Oct. 22-24, 1931.

small a-c. motor. The front disk has cam shaped teeth while the rear disk is smooth.

This regulator remains inoperative with both pairs of contacts out of engagement as long as no change in excitation is required. For slight changes in voltage only the front contacts L_1 and R_2 and the motor operated field rheostat are affected, a "notching" action resulting varying from a single brief impulse to practically continuous operation of the motor depending upon the correction required. Only for greater changes in voltage do the back contacts L_2 and R_2 and the high speed relays X and Y come into action to maintain the voltage until the motor operated rheostat has moved to a position corresponding to the required excitation.

The notching action of the front contacts in conjunction with the intermittent operation of the rheostat prevents overtravel of the latter with consequent hunting. The back contacts go into operation when the a-c. voltage has changed from 3 to 15 per cent, according to the adjustment made. The regulator will hold constant voltage for all frequencies between 25 and 85 cycles.

Resistance in Field Circuit

In Fig. 3 are indicated the connections and devices used to insert resistance automatically in the alternator field circuit upon the occurrence of overvoltage. The contact making voltmeter type of overvoltage relay endeavors to hold a-c. voltage in accordance with its setting by repeatedly opening and closing a contactor connected across a resistor in the alternator field circuit. As soon as the contactor opens, the setting of the overvoltage relay may be changed if desired to hold normal voltage or a voltage of some predetermined value. This change in the setting of overvoltage relay is accomplished by the use of a hand reset relay which, upon closing its contacts, changes the value of resistance in the coil circuit of the overvoltage relay. In the case under consideration the overvoltage relay was set to operate at approximately 16.8 kv. or 22 per cent above normal voltage.

Test Results

Results of dropping load on the 47,000 kva. generator under the conditions mentioned are shown in Figs. 4, 5, and 6. When load was dropped, there were two or three cycles of single-phase operation caused by the three poles of the 110-kv. circuit breaker not opening at exactly the same moment. Because of this it may be noticed that the alternator field current did not decrease instantaneously at zero time, but dropped to its new value in about three cycles, which is reasonable when it is considered that it took that time to drop the load completely. In all cases where a 40,000-kw. load was dropped, a maximum of 138 per cent of normal speed was reached in approximately 3.5 sec.

Referring to Figs. 4 and 5, approximately 4 per cent higher alternator voltage was obtained with the compound than with the shunt connected main exciter when a 40,000-kw. load was tripped, using the wheatstone bridge arrangement. Also, with the shunt exciter the overvoltage was reduced more quickly than with the compound exciter. When using the shunt exciter the maximum voltage was 16.5 kv. or approximately 20 per cent above normal, and for the compound exciter, 17.2 kv. or approximately 25 per cent above normal. This shows very clearly the effectiveness of the regulator with the wheatstone bridge arrangement because with no regulator the alternator voltage would have reached 180 per cent of normal value when tripping the

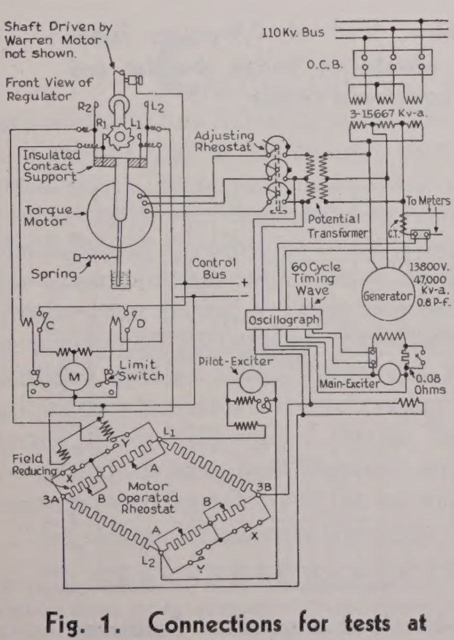


Fig. 1. Connections for tests at Spier Falls station

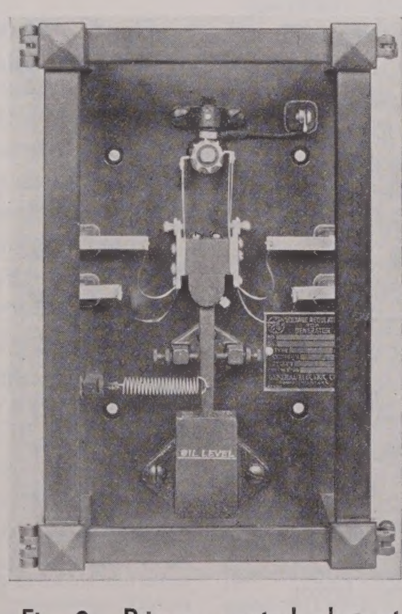


Fig. 2. Primary control element of high speed regulator

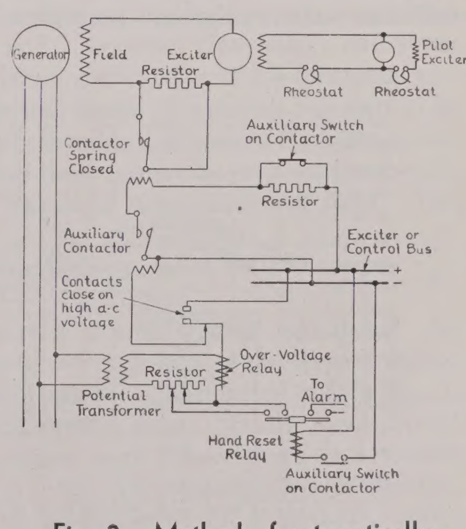


Fig. 3. Method of automatically inserting resistance in alternator field circuit upon occurrence of overvoltage

transformer high voltage circuit breaker and dropping a 40,000-kw. load of 0.9-power factor. Without the effect of transformer magnetizing current as would be the case if load were tripped on the low voltage side of the transformer, the alternator voltage would reach double value with no regulator or voltage limiting means.

What may be accomplished in limiting alternator voltage by automatically inserting resistance of 1.12 ohms in the alternator field circuit when dropping a 40,000-kw. load of 0.9-power factor is shown in Fig. 6. In this test the overvoltage relay shown in Fig. 3 was set to operate at 16.8 kv., and it held this value. It may be noticed that the maximum alternator voltage reached was 17.7 kv., or approximately 128 per cent of normal. In attempting to hold a-c. voltage the overvoltage relay opened and closed the contactor connected across the 1.12-ohm resistor in the alternator field circuit, giving the sudden increases and decreases in alternator voltage. This operation continued until the regulator could gain control, and lower the a-c. voltage to a point where the overvoltage relay would not operate. This was accomplished at the end of approximately 10 sec., as shown by a high speed voltage chart record. At that point, the regulator, which had been doing all it could to reduce the excitation, finally gained control and brought the voltage back to normal in about another 5 sec. The rather long time which elapsed before the regulator gained control was due to the use of a series rheostat instead of the wheatstone bridge arrangement.

Conclusions

The tests described indicate that a suitable regulator and wheatstone bridge type of exciter field rheostat set to give zero or slightly negative main exciter armature voltage provide a simple means of limiting overvoltage caused by dropping load. Under ordinary conditions such equipment functions as required to hold normal a-c. voltage, but at the same time is ready to prevent the voltage from reaching dangerous values which would overstress the insulation of generators and connected apparatus. Furthermore, the use of such equipment has made possible the design of lightning arresters and protective apparatus to give better protection and at the same time not be subject to failure on overdynamic voltage.

The alternative method of automatically inserting resistance in the alternator field circuit also is very effective in keeping the a-c. voltage within desired limits when load is lost. Therefore, this method is available for use where overvoltage protection is needed and there are no generator voltage regulators; or where regulators are being used, but the excitation system is of the older type and it is neither desirable nor economical to change the exciter field circuit to include such equipment as the wheatstone bridge.

In the tests described, load was dropped by tripping the transformer high voltage circuit breaker and therefore the effect of line charging current was not included. The effect of charging current is to give a higher value

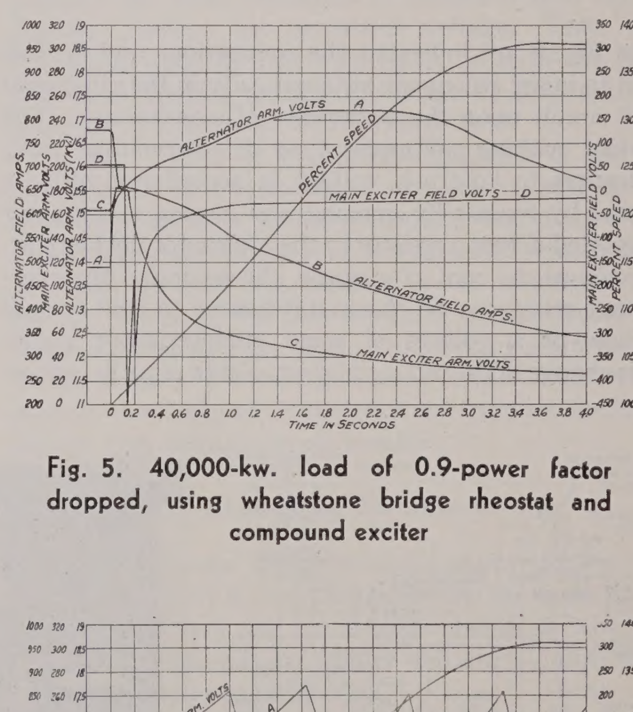


Fig. 5. 40,000-kw. load of 0.9-power factor dropped, using wheatstone bridge rheostat and compound exciter

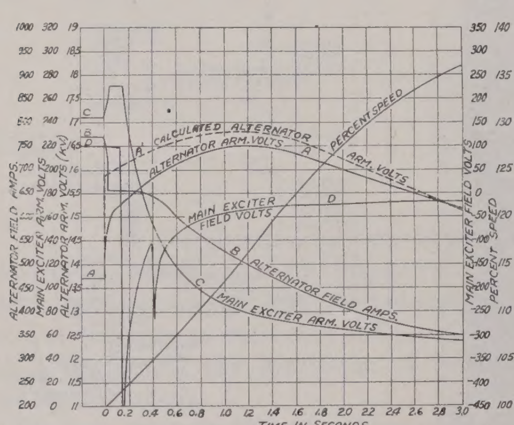


Fig. 4. 40,000-kw. load of 0.9-power factor dropped, using wheatstone bridge rheostat and shunt exciter

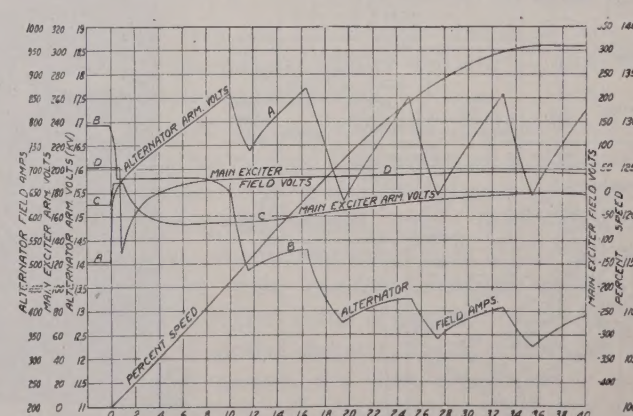


Fig. 6. 40,000-kw. load dropped. Resistance inserted in alternator field circuit

of voltage, the amount varying with the length and voltage of the line and the number of generators and transformers connected after load is lost.

Curve A^1 in Fig. 4 shows that it is possible to calculate very closely the overvoltage on generators caused by the dropping of load. The method of this calculation is described in the companion article immediately following.

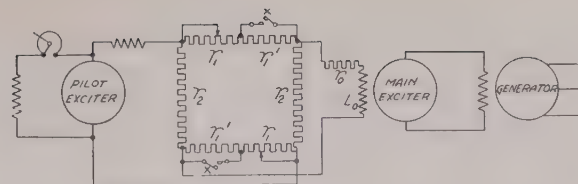


Fig. 1. Schematic diagram of excitation circuits using wheatstone bridge type rheostat

Calculation of Generator Overvoltage

Following the sudden loss of load by an alternator, speed and terminal voltage tend to increase rapidly. In the following article, a method is outlined for predetermining such overvoltage, with especial reference to waterwheel generators. Test results which have been obtained on an actual machine prove that the curve of overvoltage which may be calculated by this method closely follows that secured in practise.

By
J. W. BUTLER
Associate A.I.E.E.

General Electric Co.,
Schenectady, N. Y.

CALCULATION of dynamic overvoltage of alternators following the sudden dropping of load is a subject that as yet has not been covered very extensively. The predetermination of the extent of such overvoltage is very desirable, however, in that it enables the necessary precautions to be taken to guard against the disadvantages which may result from voltages greater than normal. These may be especially serious in waterwheel generators. The method of calculation outlined applied especially to this type of unit, and allows the alternator terminal voltage to be expressed in terms of time subsequent to the loss of load. Test results which have been obtained on a 37,500-kw. machine prove the accuracy of the calculated results.

The factors influencing this type of overvoltage are overspeeding of the units, and the action of the generator voltage regulators. The major portion of overvoltage subsequent to loss of load is contributed by the increase in speed of the generator itself rather than by the increase in excitation due to overspeeding of the exciters. As a result, simplifying assumptions may be made relative to the exciter characteristics without appreciably affecting the accuracy. Assumptions used in this article and applying to the pilot exciter are as follows:

1. The time constant of the pilot exciter shunt field is so small as compared to the equivalent time constant of the speed-time curve that the shunt field current follows the speed exactly.

2. The load saturation curve of the pilot exciter coincides with the no-load saturation over the operating range. This is approximately true for pilot exciters that are flat-compounded and liberally designed.

Assumptions applying to the main exciter are:

1. Shunt wound main exciters will be considered, as shunt windings are generally believed to have the better characteristics and are commonly used at the present time.

2. The inductance of main exciter field circuit remains constant, but is corrected by a factor, depending upon the type of field structure.

3. The open circuit instead of the load saturation curve of the main exciter is used.

These last two assumptions compensate in a measure for the effect of the voltage coming down on a higher curve than the saturation curve, due to eddy currents when the field current decreases rapidly.

Heaviside's operational calculus is used in the analysis. The multiplier 1 appearing in the operational form of eqs. 1, 2, 4, 6, and 7, is called Heaviside's unit function. It is used in the derivations of his formulas, and even if it is not written down, it is tacitly assumed to be present. Generally speaking, it means that the action begins at $t = 0$ and time cannot be counted backward; that is, negative values of time cannot be used. The symbol p is the Heaviside operator, which replaces $\frac{d}{dt}$ wherever it appears in the differential equations. An explanation of these terms as well as the steps involved in solving these differential equations to obtain eqs. 3, 5, and 8, is given in various texts. "Operational Circuit Analysis" by V. Bush, and "Heaviside's Operational Calculus" by E. J. Berg are especially recommended. However, if it is desired to work out a particular problem without going into it deeply, eqs. 3, 5, and 8 may be used without studying either their origin or Heaviside's operational calculus.

Especially written for ELECTRICAL ENGINEERING and including the information given in the appendix to "Overvoltage on Transmission System Caused by Dropping Load" (**No. 31-140**) presented at the A.I.E.E. South West District meeting, Kansas City, Mo., Oct. 22-24, 1931.

Pilot Exciter Armature Voltage

With the assumptions previously outlined, the curve of pilot exciter armature voltage readily may be obtained as follows: From the saturation curve of the pilot exciter at normal speed, saturation curves for 110-per cent, 120-per cent, etc., speed may be drawn. Then drawing in the RI line (product of field resistance and field current) as indicated on Fig. 2, the voltage for each speed is read as the intersection of the RI line and the saturation curve for the particular speed.

A curve ordinarily may be obtained from the waterwheel manufacturer giving the speed of the unit upon sudden loss of load as a function of time; hence, by using the values of voltage for different speeds in conjunction with this speed-time curve, a voltage-time curve may be drawn. An empirical expression for this pilot exciter voltage-time curve in operational form using one exponential is

$$e_1 = a + \frac{b-a}{T_1 p + 1} 1 \tag{1}$$

where

a = initial value of voltage

b = final value of voltage

$$p = \frac{d}{dt}$$

and

$$\text{the time constant } T_1 = \frac{t_o}{\log_\epsilon \dfrac{b-a}{b-e_o}}$$

e_o and t_o are the coordinates of a particular point on the curve. It is preferable to take a point in the region where the greatest accuracy is desired.

Main Exciter Field Current

The next step is to determine the main exciter field current considering regulator action on the bridge rheostat, and overspeeding of the pilot exciter. The excitation circuits, employing the wheatstone bridge type rheostat, are shown on Fig. 1. The method will be developed for this type of rheostat, but it is obvious that the method of attack would be the same for other types of control. The application and operation of the bridge type of rheostat are described in the companion article "Generator Overvoltage When Dropping Load" by E.J. Burnham, immediately preceding.

The voltage e_1 operates upon the bridge circuit, in which r_o and L_o are the shunt field resistance and inductance respectively and r_1, r_1' and r_2 are the rheostat resistances. Upon indication of overvoltage, the regulator opens contacts x inserting both blocks of r_1' in the circuit. The value of r_1' usually is sufficient to reverse the excitation.

Consider the case when the regulator fails to operate. The current through the main exciter field will be

$$i_o = \frac{a\,(r_2 - r_1)}{2\,r_1 r_2 + r_o\,(r_2 + r_1)} + \frac{r_2 - r_1}{2\,r_1 r_2 + (r_o + pL_o)(r_2 + r_1)} \times \frac{b-a}{T_1 p + 1} 1 \tag{2}$$

The solution of which is

$$i_o = \frac{a}{m} + \frac{b-a}{nT_1}\,(A_o + A_1 \epsilon^{-a_1 t} + A_2 \epsilon^{-a_2 t}) \tag{3}$$

where

$$m = \frac{2\,r_1 r_2 + r_o\,(r_2 + r_1)}{r_2 - r_1} \qquad n = \frac{L_o\,(r_2 + r_1)}{r_2 - r_1}$$

$$A_o = \frac{1}{a_1 a_2}$$

$$A_1 = \frac{1}{-\,a_1\,(a_2 - a_1)} \qquad a_1 = \frac{m}{n}$$

$$A_2 = \frac{1}{-\,a_2\,(a_1 - a_2)} \qquad a_2 = \frac{1}{T_1}$$

The contacts x are opened by a voltage regulator in 3 cycles after the indication of 5 per cent overvoltage. This overvoltage will appear the instant load is lost. Due to the quick action of the regulator and the time constants of the circuits involved, it can be assumed with very little error that the loss of load and opening of the contacts x occur simultaneously.

Hence, the equation for the current after the regulator acts can be written

$$i_o = \frac{a\,(r_2 - r_1)}{2\,r_1 r_2 + r_o\,(r_2 + r_1)} - 2\left[\frac{a\,(r_2 + r_o)}{2\,r_2 r_1 + r_o\,(r_2 + r_1)} \times \frac{r_2 r_1}{2\,r_2\,(r_1 + r_1') + (r_o + pL_o)\,(r_2 + r_1 + r_1')}\right] 1 + \frac{r_2 - r_1 - r_1'}{2\,r_2(r_1 + r_1') + (r_o + pL_o)(r_2 + r_1 + r_1')} \times \frac{(b-a)}{T_1 p + 1} 1 \tag{4}$$

The solution being

$$i_o = Y_1 + Y_2 \epsilon^{-a_2 t} + Y_3 \epsilon^{-a_3} \tag{5}$$

where

$$Y_1 = \frac{b\,(r_2 - r_1 - r_1')}{2\,r_2\,(r_1 + r_1') + r_o\,(r_2 + r_1 + r_1')}$$

$$Y_2 = \frac{(r_2 - r_1 - r_1')\,(b-a)}{L_o\,(r_2 + r_1 + r_1')\,(a_2 - a_3)}$$

$$Y_3 = \frac{(r_2 - r_1 - r_1')\,(b-a)}{[2\,r_2\,(r_1 + r_1') + r_o\,(r_2 + r_1 + r_1')]\,[(T_1\,a_3 - 1)]} + \frac{2\,a\,(r_2 + r_o)\,r_2 r_1'}{[2 r_2 r_1 + r_o (r_2 + r_1)]\,[2 r_2 (r_1 + r_1') + r_o (r_2 + r_1 + r_1')]}$$

$$a_3 = \frac{2\,r_2\,(r_1 + r_1')}{L_o\,(r_2 + r_1 + r_1')} + \frac{r_o}{L_o}$$

$$a_2 = \frac{1}{T_1}$$

Thus eq. 5 gives main exciter field current considering regulator action on the bridge rheostat and overspeeding of the pilot exciter. This current flowing through the main exciter shunt field produces main exciter armature voltage and current which will now be considered.

Main Exciter Armature Voltage and Current

By plotting eq. 5, the curve of main exciter armature voltage can be determined, considering the increase in speed, as follows: For any particular value of i_o flowing at time t the voltage is read from the saturation curve (taken at normal speed). From the speed-time curve of the unit, the speed of the set can be read for the particular time t chosen, and the voltage increased in direct ratio. The voltage function thus obtained is that which operates upon the generator field. The operational equation of such a curve, similar to that of eq. 1, is

$$E = E_o - \frac{E_1}{T_2 p - 1}\,1 \qquad (6)$$

where

E = main exciter armature voltage

E_o = voltage before loss of load

E_1 = increase in main exciter armature voltage (final value minus the initial value E_o)

T_2 = time constant obtained from main exciter armature voltage-time curve

The problem now is to find an equation of generator field current as a function of time. Having this, generator terminal voltage for any value of field current can be read directly from the saturation curve and corrected for the increased speed at the particular time chosen.

There are two factors affecting the generator field current. Upon sudden loss of load, the field current drops immediately to a value necessary to produce flux back of transient reactance. It then builds up to a value that existed before loss of load, according to the open circuit time constant of the generator field circuit, and provided constant slipring voltage is maintained. But in this case under consideration, due to the regulator action and increased speed of exciters, the slipring voltage varies according to eq. 6.

With the voltage expressed by eq. 6 applied to the sliprings, and considering the drop of current at $t = 0$, the following type of equation for generator field current will result:

$$I = I_o - I_o' \frac{p}{T'_{do}p + 1}\,1 + \frac{E_1}{r}\,\frac{1}{(T_2 p + 1)(T'_{do}p + 1)}\,1 \qquad (7)$$

The solution being

$$I = I_o - I_o'\epsilon^{-c_1 t} + I_1\,(C_o + C_1\epsilon^{-c_1 t} + C_2\epsilon^{-c_2 t}) \qquad (8)$$

where

I_o = field current before loss of load

$I_1 = \dfrac{E_1}{r T_2 T'_{do}}$

T'_{do} = open circuit time constant of generator

r = resistance of field circuit

I_o' = the decrease in field current the instant load is lost. This calculation is explained under the heading "Calculations for Instant of Dropping Load" following.

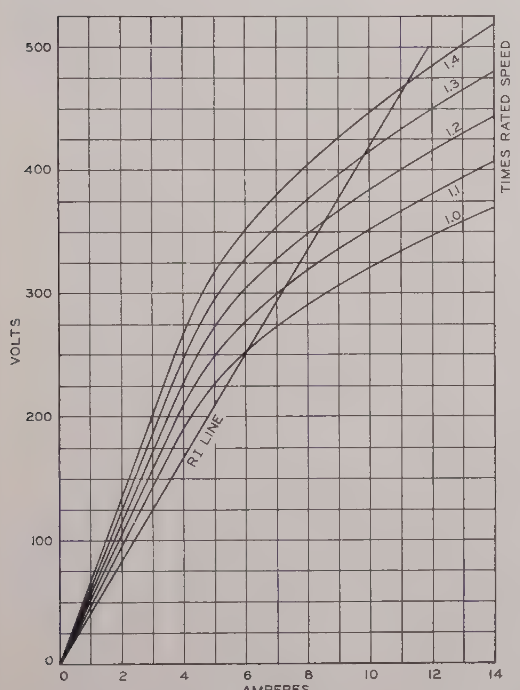


Fig. 2. Pilot-exciter saturation curves for various speeds

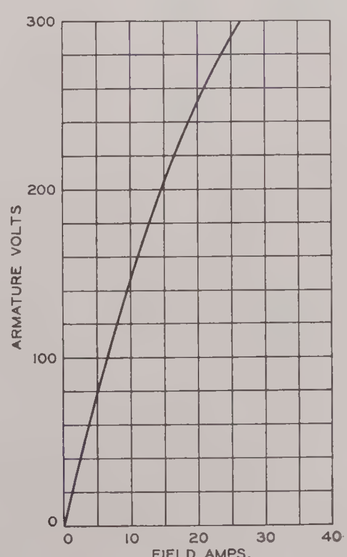


Fig. 3. Main-exciter saturation curve

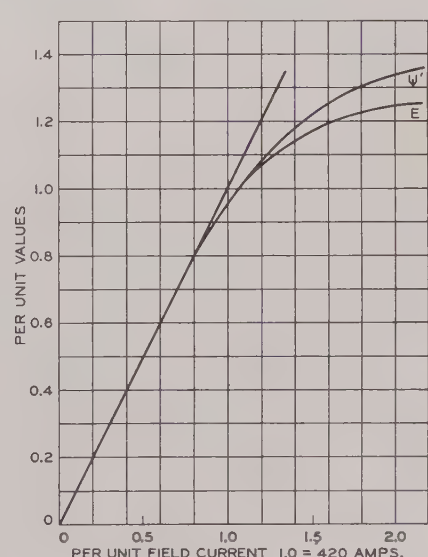


Fig. 4. Calculated linkage and voltage saturation curves of generator

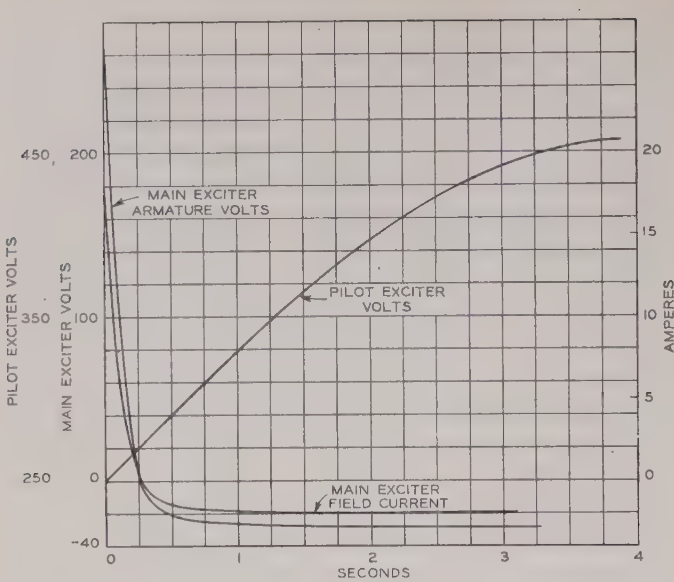


Fig. 5. Exciter characteristics

$$C_o = \frac{1}{c_1 c_2}$$

$$C_1 = \frac{1}{-c_1(c_2 - c_1)} \qquad c_1 = \frac{1}{T'_{do}}$$

$$C_2 = \frac{1}{-c_2(c_1 - c_2)} \qquad c_2 = \frac{1}{T_2}$$

After plotting eq. 8, the curve of generator terminal voltage can be determined by using the generator saturation curve and speed-time curve as was explained for main exciter armature voltage. This completes the calculation for conditions at the generator terminals. Although quite involved, and not covered in this article, the same method can be extended to include a long transmission line remaining connected after load is dropped.

Calculation for Instant of Dropping Load

The calculation of generator field current drop and armature voltage rise the instant load is dropped, is given in "Synchronous Machines—III" by R.E. Doherty and C.A. Nickle, A.I.E.E. Trans., V. 46, 1927, p. 1-18; and "Two Reaction Theory of Synchronous Machines" by R.H. Park, A.I.E.E. Trans., V. 48, July 1929, p. 716-30. Extending these derivations to include pole leakage due to saturation, the total per unit field flux linkage under load is

$$\Psi = \frac{x_{ad}}{x_d - x'_d}\left[I - i_d(x_d - x'_d) + I_s \frac{x'_d - x_{ld}}{x_{ad}} \right] \tag{9}$$

All quantities are in per unit values and defined as follows:

x_{ad} = armature reaction reactance direct axis
x_d = synchronous reactance direct axis
x_q = synchronous reactance quadrature axis
x'_d = transient reactance direct axis
x_{ld} = armature leakage reactance direct axis
i_d = $i \sin(\delta + \phi)$
i = load current
δ = load angle
ϕ = power factor angle
I = full load excitation neglecting saturation
I_s = excitation due to saturation

During sudden changes of load, the quantity in the bracket of eq. 9 must remain constant. This may be denoted by Ψ' as follows:

$$\Psi' = I - i_d(x_d - x'_d) + I_s \frac{x'_d - x_{ld})}{x_{ad}} \tag{10}$$

A curve of Ψ' and per unit field current can be plotted from the open circuit saturation curve of the machine. Then for a given load condition Ψ' can be calculated, and when load is lost it remains constant the first instant; hence, from the curve of Ψ' the per unit excitation the first instant can be obtained and the corresponding voltage read from the saturation curve.

The effect of amortisseur winding currents is neglected due to their fast time constant.

Numerical Example

An application of the method described will be illustrated by calculations for a 37,500-kw., 0.8-power-factor generator. Actual tests were made on this machine and provide a check as to the accuracy of the method.

Generator constants:

X_{ad} = 0.76	X_{ld} = 0.27
X_d = 1.03	T'_{do} = 4.5 seconds
X_q = 0.65	r = 0.337 ohms (field circuit resistance)
X'_d = 0.37	Saturation curve, Fig. 4

Main exciter constants:

r_o = 4.32 ohms (shunt field resistance)
L_o = 7 henrys (inductance of shunt field circuit)
Saturation curve, Fig. 3.

Pilot exciter:

Saturation curve, Fig. 2.
Bridge type rheostat constants:
r_1 = 4 r_1' = 100 r_2 = 48 (refer Fig 1)

By using the saturation curve of Fig. 2 for various speeds and the speed-time curve of Fig. 6, the pilot exciter voltage curve Fig. 5 is plotted. Eq. 1 then becomes

$$e_1 = 250 + \frac{210}{2p+1} 1$$

With the constants given for the rheostat and main exciter, eq. 5 becomes

$$i_o = -2.3 + 1.16\ \epsilon^{-0.5t} + 19.35\ \epsilon^{-10t}$$

The curve of i_o is plotted as shown on Fig. 5. By using this, the speed-time curve of Fig. 6, and the saturation curve of Fig. 3, a curve of slipring (main exciter armature) voltage as a function of time is plotted as shown in Fig. 5. The operational equation, eq. 6, becomes

$$E = 265 + \frac{295}{0.165\ p + 1}\ 1$$

Hence, eq. 8 becomes

$$I = 785 - I_o'\ \epsilon^{-t/4.5} - 1180\ (0.75 - 0.78\ \epsilon^{-0.22t} + 0.03\ \epsilon^{-6t})$$

It will now be shown how to calculate the value of I_o'. For the particular machine under consideration, eq. 10 becomes

$$\Psi' = I - i_d\, 0.66 + 0.132\ I_s$$

The machine was delivering 40,000 kw. at 0.9 power factor and normal voltage, or 44,500 kva. when load was dropped. Hence, based on machine rating 0.94 per unit current was flowing.

For this condition

$$\delta + \phi = \tan^{-1} \frac{ix_q \sin = \phi}{\cos \phi}$$

$$\delta + \phi = 49 \text{ deg.}$$

Hence

$$i_d = 0.94 \sin 49 \text{ deg.}$$
$$= 0.71$$

I is excitation neglecting saturation and is obtained as follows: Referring to Fig. 7

$$e_d = I = e_t \cos\theta + j\ (e_t \sin\theta + i_a x_d)$$
$$= 0.9 + j\ (0.435 + 0.97)$$
$$= 1.67$$

where

e_d = per unit voltage back of synchronous reactance
I = per unit field current to produce e_d
e_t = per unit terminal voltage
i_a = per unit armature current
θ = power factor angle

I_s is excitation due to saturation and is obtained as follows. Referring again to Fig. 7

$$e_v = I' = e_t \cos\theta + j\ (e_t \sin\theta + i_a x_{ld})$$
$$= 0.9 + j\ (0.435 + 0.254)$$
$$= 1.13$$

where

e_v = per unit voltage back of leakage reactance
I' = per unit field current to produce e_v

Thus 1.13 is the per unit excitation necessary neglecting saturation; but from the saturation curve we find it takes 1.38 per unit excitation to get 1.13 per unit voltage, hence, $I_s = 0.25$ due to saturation. Therefore, the value of Ψ becomes

$$\Psi = 1.67 + 0.71\ (0.66) + 0.132\ (0.25)$$
$$= 1.24$$

When the machine loses load, i_d goes to zero and the first instant Ψ' must remain constant. So we turn to the no-load curve of Ψ' and find that the value of field current necessary to produce 1.24 Ψ' is 1.58. Also, from the no-load saturation curve we find that 1.58 field current produces 1.18 voltage, the value obtained at $t = 0$.

On this particular machine, unit field current is 420 amperes (air-gap line, normal voltage). Hence, the value of field current the first instant is 663 amperes and I_o' is 122 amperes.

Using this value of I_o' and dividing through by 420 to change to per unit, we get for generator field current

$$I = (1.87 - 0.29\ \epsilon^{-0.22t}) - 2.8(0.75 - 0.78\ \epsilon^{-0.22t}) + 0.03\ \epsilon^{-6t})$$

Plotting this equation results in the current curve of Fig. 6 and using this with the open-circuit saturation curve of the generator and its speed-time curve, the generator terminal voltage is plotted as in Fig. 6. The results check with surprising accuracy, values obtained by test considering that there were four or five cycles of arcing in the breaker disconnecting the load and that calculated values of unsaturated machine constants were used.

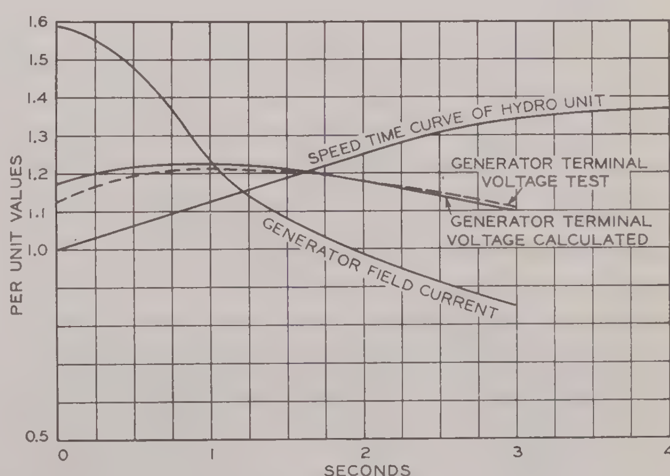


Fig. 6. (Above) Generator and hydro unit characteristics

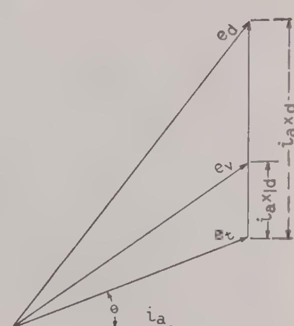


Fig. 7. (Right) Simple vector diagram of a synchronous machine

Tape Armored Telephone Toll Cable

Toll cables buried directly in the earth are coming into increased use. Such cables are not installed in the usual clay conduit but are protected by layers of paper, jute, and steel tapes. Complete equipment for laying this cable has been developed.

Fig. 1. Lower part of cable-laying plow and tube

By
C. W. NYSTROM
Associate A.I.E.E.

Southwestern Bell Tel. Co., St. Louis, Mo.

TOLL CABLE in this country has in the past been installed either aerially on pole lines, or underground in clay conduit, depending largely upon the number of cable units needed to meet service requirements over a given period of time. Although there will continue to be definite fields for these two types of construction, there are many routes where ground conditions are favorable and on which one or two cables will serve all needs for a long period; it is for these cases that buried tape armored cables were developed.

The cable is termed "tape armored" because of its outer protection. Lead-sheath cable of the type ordinarily used for toll service is covered first with a wrapping of paper followed by two layers of jute roving. Two steel tapes, one over the other, then are applied, each tape being 2 inches wide and 41 mils thick. A separation of one-half inch is maintained between adjacent turns of the tape, and the outer layer is so placed that it covers the space left between the windings of the inner layer. Two wrappings of jute cover the tape. The lead sheath, paper, jute, and steel tapes are thoroughly coated with an asphalt compound; to prevent adjacent layers from sticking together on the cable reels the completed cable is given a coat of whitewash. Such a cable of so-called full size has a diameter of 3¼ in. and a weight of 11.3 lb. per ft. as compared with 2⅝-in. diameter and 8-lb. weight of unarmored cable.

Buried tape armored cables possess several advantages over cables carried on pole line or in underground conduit:

1. Easements for buried tape armored cable on private rights-of-way may sometimes be obtained more cheaply than for pole lines, as the use of the land for ordinary agricultural activities is not disturbed.

2. Induced currents from paralleling power lines are appreciably less than in unarmored aerial or underground cables, due to the shielding effect of the steel tapes. This factor is discussed in "Trends in Telephone and Power Practise as Affecting Coordination," by W. H. Harrison and A. E. Silver, A.I.E.E. TRANSACTIONS, June 1931, p. 437-447.

3. Cable may be laid to follow the contour of rough country and have sharp bends to avoid obstructions, while conduit must have a fairly even grade and long radius curves to permit cable being pulled through it.

4. Manholes are required at spacings of from 500 to 700 ft. if conduit is provided, while with tape armored cables, manholes may be omitted except at loading points which normally occur at 6,000-ft. intervals.

On the other hand, as tape armored cables are buried directly in the earth, the location and repair of troubles are generally more difficult and expensive than for aerial cables. However, improvements in methods for maintaining buried cables should reduce such costs, and in any event, the amount of trouble per cable mile reasonably may be expected to be much less than on aerial cables because of their security from fire, storm, and bullets.

The question of the best possible location for buried cable is one requiring careful consideration. It is thought that right-of-way on private property generally is more desirable than on public highways where road improvements are liable to necessitate expensive cable relocation. On the other hand, the difficulty of obtaining private property easements at a reasonable price, or high construction costs on privately owned land, may make it advisable to place the cable on the highway and so locate it as to subject it to the least probability of having to be moved.

Although with fairly open country, frequent roads, and adequate maps, ordinarily there would be no necessity for a preliminary aerial survey, the first tape armored toll cable in this country was installed by the Southwestern Bell Telephone Company between Fort Worth and Cisco, Texas, in country which made it advisable to photograph the general route from an airplane. The topography for 85 miles of the total 100 miles on this route is extremely rugged, with large quantities of rock in the soil and the ground covered with dense growths of scrub oak and other underbrush. Roads are few and accurate maps were not obtainable. However, the aerial photographs enabled the tentative route to be marked out easily and was of assistance in

Based upon "Tape Armored Telephone Toll Cable" (**No. 31-134**) presented at the A.I.E.E. South West District meeting, Kansas City, Mo., October 22-24, 1931.

expediting the ground survey which is of course necessary in any event.

As the Fort Worth-Cisco and other tape armored cables later installed are largely on private rights-of-way, in many instances in cultivated fields, special tractors of the caterpillar type had to be designed to transport the 5-ton cable reels over soft and often muddy ground. There have been also some developments of four-wheel-drive truck equipment for handling deliveries on the right-of-way as well as on the highway.

The equipment for digging the trench, laying the cable, and making the backfill has changed considerably since the early design. For trenching in earth, a commercial wheel type excavating machine was first used and proved quite satisfactory until soil containing a considerable quantity of rock was encountered. A rock-breaking plow then was designed, and answered the needs quite satisfactorily except in cases where solid rock was encountered and pneumatic drills and blasting were required. The cable was laid in the trench directly from the reel, except in such cases as crossing under paved highways and pipe lines, or on steep slopes, where the cable was pulled over rollers placed on the bottom of the trench. Backfilling was accomplished by a separate machine of the type commonly used for filling trenches by scraping the upturned dirt back into the trench.

The use of the rock-breaking plow focused attention on the further possibility of combining the equipment. This led to the development of the outfit shown in Fig. 2 which not only digs the trench but also lays the cable and then fills the excavation, all in one operation. The equipment consists essentially of two main parts, a chassis, and a vertical central portion which may be raised or lowered to bury the cable at depths up to 28 inches. Properly speaking the plow of this equipment does not dig a trench, but merely cuts a slot into the ground. Some earth is thrown out and after the cable is laid this is drawn to the center of the slot by the backfiller. If desired, a tractor may be run over the disturbed earth to pack it down.

Two tractors, sometimes three, are required to pull the cable reel trailer, plow, and backfiller. The essential features of the plow and cable-laying tube are shown in Fig. 1. The forward or cutting end is a steel plate having a sharpened edge and a shoe provided at the bottom to make a larger space for the cable. Side plates are welded to the cutting blade and to the outer sides of the tube through which the cable passes. The cable enters this tube directly from the reel, and as the pipe extends into the ground, the cable is deposited at the bottom of the trench and is not dragged through the ground at any time. After laying more than 300 miles of cable, this plow is still in good condition.

Small boulders and tree roots often made progress very difficult for the cable-laying plow and it was found that with a narrow slot first cut into the earth, the usual plowing and cable laying operations were considerably expedited. The plow used for this purpose is called a rooter plow as shown in Fig. 3. It is of rugged design and fits the same chassis as the cable-laying plow so that either attachment may be used interchangeably.

The lead sleeve covering the cable splice necessary every 750 ft. was at first protected by a cast iron case. This covering was found to be rather expensive and it was felt that a cheaper protection consisting of a wood case made of 2-in. creosoted yellow pine lumber would serve equally well. Space for branch cables is provided by two openings in one of the end pieces. The exposed lead sheath and sleeve within the case are painted with an asphaltum compound and covered with three layers of muslin tape which also is painted with the compound. The loading manholes for tape armored cables also are of 2-in. creosoted yellow pine. After the top is placed, it is covered with earth, the depth from the surface to the top of the manhole being at least 18 inches. This is necessary as it is desirable not to interfere with the use of the land for ordinary agricultural purposes. The type of manhole illustrated in Fig. 4 costs less than one-third that of the most economically built concrete manhole of similar dimensions. Markers

Fig. 2. Complete cable-laying equipment of improved design, consisting of tractors, chassis for cable reel, cable-laying plow and tube, and backfiller

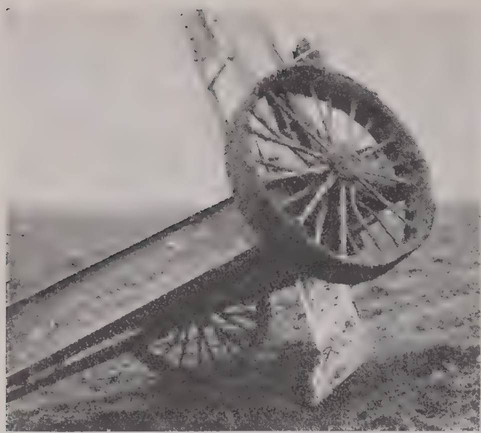


Fig. 3. (Left) Rooter plow which may be placed in the chassis, for cutting a preliminary slot in difficult ground containing tree roots and small boulders

Fig. 4. (Right) Wood manhole. No floor is provided, the loading coil pots being buried in the earth

usually are provided at each manhole and at points along the cable route to enable the ready location of trouble, and the placing of additional loading coils or a future cable. To prevent damage by other excavating activities, warning signs are placed on each side of a road under which cable is laid, at pipe lines and railroad crossings, and at similar locations.

Electrical tests on tape armored cables do not differ appreciably from those used for unarmored cables. It is estimated that the minimum number of tests normally required is 5,150 individual measurements per mile of cable, and if conditions difficult of correction are encountered, many of the tests must be repeated. For the cables between St. Louis and Dallas, the estimated minimum number of individual test measurements reaches the rather astounding total of 4,500,000.

Since troubles in buried cables may be more difficult to locate and clear than for those on pole lines or in clay conduits, it is desirable that tape armored cable, when first placed, be as free as possible from defects which are likely to allow moisture to enter. The lead sheath is tested with nitrogen under pressure, at the factory, upon arrival at the destination, just before the cable is laid or plowed in, one or two days later, and then, before the splicing operations begin. As splicing necessitates the removal of the sheath at each end of a length of cable, most of the gas is lost. Nitrogen again is introduced upon completion of splicing in one loading section, 6,000 ft., and is allowed to remain for about two days. If no leaks are found, the loading coils are spliced in, and the loading splices tested with gas. Gage readings are taken and recorded during all these tests.

A discussion of the application of gas pressure testing for the detection of sheath breaks during installation and with the cable in service has been given by B. S. Wagner and A. C. Burroway in "Recent Developments in Telephone Construction Practises," A.I.E.E. TRANSACTIONS, July 1929, p. 836-848. In connection with constant gas-pressure testing on completed cables, however, two recent improvements seem worthy of mention here. First, the combined contactor-terminal which is compact, gas-tight, may be mounted either in a manhole or on a post, and is so constructed that the

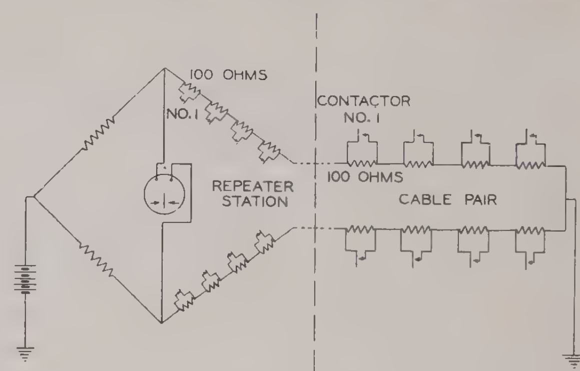


Fig. 5. Circuit of improved gas pressure alarm

contactor may be replaced very easily. The second is an improved alarm circuit that avoids a difficulty possible in the earlier circuits; namely, the operation of any one contactor will render the alarm circuit insensitive to the subsequent operation of any other contactor in the 50-mile cable section until the first contactor is disconnected or the gas pressure is raised in the cable section it covers. This difficulty, resulting from the fact that a single alarm circuit is used for an entire repeater section of cable, is avoided by the plan shown in Fig. 5, based on the wheatstone bridge principle. Contactors at various points of the cable pair operate on reduced gas pressure and they short circuit given values of resistance. Equal values of resistance are located in the bridge at the repeater station. As each pair of resistances has a different value, the attendant at the repeater station merely inserts a non-metallic plug in each jack in turn until the correct one is found as evidenced by silencing of the alarm. The bridge then is rebalanced and remains so until another contactor operates.

To protect the cables during periods when the gas alarm is inoperative, as, for example, when a large sheath break or repair operation may permit practically all the gas to escape from a plug section, another maintenance device known as the low insulation resistance alarm is often used. This operates when moisture entering the cable lowers the insulation resistance between the conductors and the cable sheath. A number of pairs in the outer layer adjacent to the lead

sheath is connected to a relay mechanism in the repeater station which automatically and in regular sequence switches these conductors to a sensitive insulation measuring device. A decrease in the resistance below a predetermined value causes an alarm to operate, and wheatstone bridge measurements then are made to locate the trouble The exceedingly small currents flowing through the moistened insulation are amplified by vacuum tubes sufficiently to operate the alarm.

No direct comparisons are available on which to base the relative costs of aerial and buried tape armored cables. However, it appears that one aerial cable on a pole line costs about 90 per cent of that of one buried tape armored cable, and two aerial cables on a pole line would cost about 85 per cent that of two buried tape armored cables. However, certain developments now under consideration promise a rather substantial reduction in the cost of buried cable and if these prove successful, it is quite probable that buried plant may cost even less than aerial cable.

There is another factor difficult of evaluation and that is the effect of service interruptions. Continuous and dependable service is one of the principal objectives of a telephone company and service failures are not only annoying to patrons but result in loss of revenue to the company. As previously discussed, it would seem that buried cable should be subject to less damage from external sources than aerial construction. If this is borne out by further experience, the use of buried cable may become more extensive.

Paralleling Rotor and Stator

A wound rotor induction machine may be given special characteristics by connecting the stator and rotor windings in parallel, either directly or through an auto-transformer. Pull-out torque, hp. output, and efficiency at large loads are increased for motor operation; and maximum kva. output is increased for operation as an induction generator.

By
A. G. CONRAD
Associate, A.I.E.E.

R. G. WARNER
Member, A.I.E.E.

Both of
Yale University
New Haven, Conn.

WOUND ROTOR induction motors normally are operated with the sliprings short-circuited. However, both rotor and stator may be independently magnetized thus permitting power to be taken or delivered through any one or two of the three channels, namely, the stator, rotor, and shaft. Further, the stator and rotor voltage and frequency can be adjusted to the same values, making it possible to parallel the stator and rotor. The advantages which have been found for such a scheme are as follows:

1. The breakdown torque of the machine operating as a motor can be approximately doubled, increasing the rating of a given motor.
2. Generator capacity and maximum output can be increased.
3. Higher efficiencies may be secured at large loads.

Starting and Operation

The principle of operation of the motor is indicated in Fig. 1. With the switch S_1 open, the stator is supplied from the three-phase line, and the rotor is connected to the armature of a synchronous generator. The latter serves as a path for the secondary current, allowing the induction motor to be started and operate much the same as if the rings were short-circuited. If the stator phase rotation is 1-2-3, the voltages induced in the rotor will be of low frequency with a phase rotation of *a-b-c*, causing current to flow in the synchronous machine armature in the order *A-B-C*. The induction motor will rotate in a clockwise direction.

With the stator disconnected from the supply and short-circuited directly or through transformers, and power supplied to the rotor from the alternator, the induction machine may be started again. If the phase rotation of

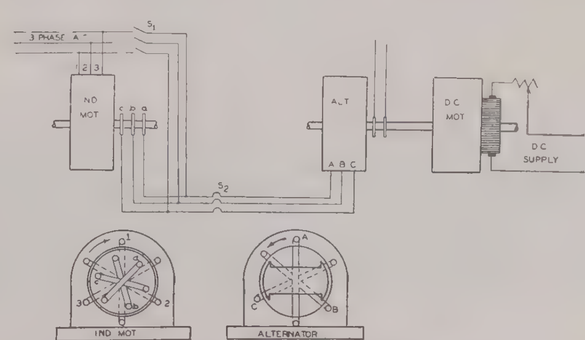


Fig. 1. Diagram illustrating operation

Based upon "An Induction Motor with Paralleled Rotor and Stator" (No. 32-27) presented at the A.I.E.E. winter convention, New York, N. Y., Jan. 25-29, 1932.

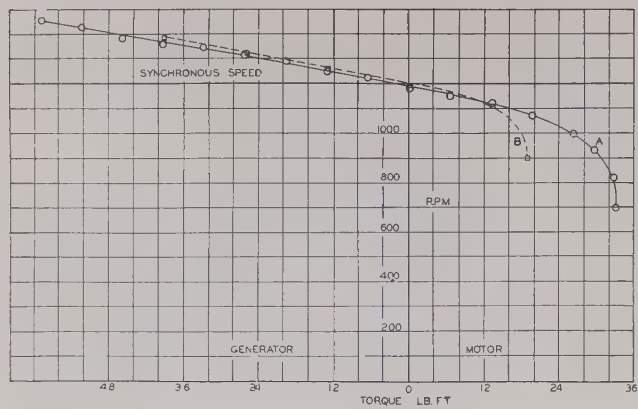
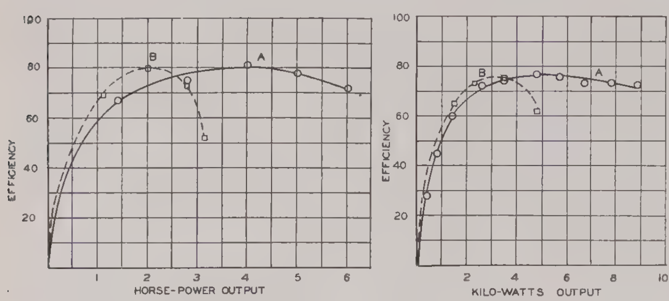


Fig. 2. Speed-torque curves of machine

Curve A—Rotor and stator paralleled
Curve B—Rotor short-circuited



Figs. 3 and 4. Efficiency as a motor (left) and as a generator (right)

Curve A—Rotor and stator paralleled
Curve B—Rotor short-circuited

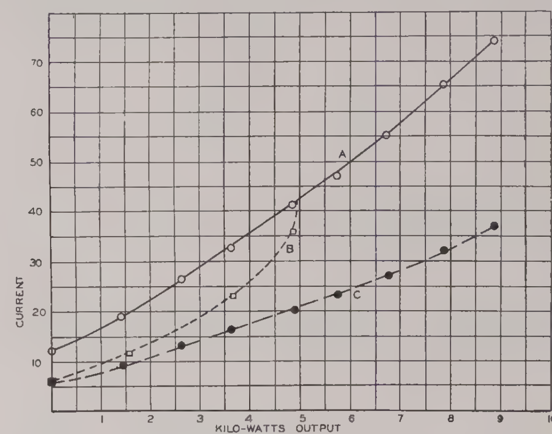


Fig. 5. Currents during generator operation

Curve A—Line current with rotor and stator paralleled
Curve B—Stator phase current with rotor short-circuited
Curve C—Stator phase current with rotor and stator paralleled

the alternator is *C-B-A* the induction machine will rotate in the same direction as above, and the low-frequency currents in the stator will be in the direction 3-2-1.

If the stator now is connected to the line in the usual manner, and at the same time the rotor continues to be supplied from the alternator with phase rotation *C-B-A*, the supply transformers will act as a low impedance path for the slip-frequency currents in the stator and the alternator will complete the path for the slip-frequency currents of the rotor. The magnitude of the voltage impressed on the rotor is dependent upon the field excitation of the synchronous machine. The frequency of the voltage depends upon the speed of the synchronous machine. By adjusting these two factors, the rotor and stator can be made to have the same voltage and frequency so that they can be synchronized and electrically connected through switch S_1. Switch S_2 now can be opened and the induction motor will continue to operate, both stator and rotor receiving power from the line. Rotation will be less than synchronous speed; the high frequency current in the stator will be in the order 1-2-3, and the low frequency currents in the order of 3-2-1. The high frequency currents in the rotor will be in the order of *c-b-a* and the low frequency current in the order of *a-b-c*. The machine when so connected has characteristics similar to those of the normal induction motor. When loaded the speed decreases slightly. When driven above synchronous speed the machine acts as an induction generator; the low-frequency currents in the stator and rotor are opposite in phase rotation to what they are as a motor.

The characteristics of the motor with its rotor and stator paralleled can be determined by applying ordinary induction motor theory. Using slip as parameter it is possible to determine the torque, stator copper loss, rotor loss, etc., by the power fed into the stator and for the same slip determine values for the same items which are produced by the power fed into the rotor.

Experimental Investigations

Calculations and analysis of operation were checked experimentally. The machine selected for tests was a wound-rotor induction motor rated 10 hp., 60 cycles, three-phase, 1,140 r.p.m., 220-volt stator, 206-volt rotor. The motor had nearly a 1 to 1 ratio of stator to rotor turns. In order to keep within the limitations of the laboratory circuits, the voltage on each phase was dropped to 110 volts, 60 cycles, and the characteristics were determined with stator and rotor paralleled. In this machine the voltage supplied to each phase is a fundamental voltage, while the current will contain not only a fundamental component but also a low-frequency component. The results of these tests are shown as curve *A* in Figs. 2 to 5. For comparison, curve *B* in each figure shows the characteristics of the motor with normal connections.

As indicated in these figures, the breakdown torque of the motor can be approximately doubled by using the stator and rotor in parallel; likewise that the generator capacity and maximum output can be increased by

the parallel connection. With the parallel connection, high efficiencies are obtained for large loads on account of reduced copper losses per unit output. However, the efficiencies are low for light loads because of larger iron losses and copper losses produced by the additional exciting current, the maximum efficiency for the two cases can be seen to be approximately the same for either the condition of motor or generator operation. The curves of Fig. 5 for generator operation show that the phase current with the parallel connection will be less than the phase current with the rotor short-circuited.

The circle diagram of the motor when the rings are short-circuited is indicated in Fig. 6. The no-load losses for this machine are very small but it can be seen that when the rotor and stator are paralleled the no-load line current contains a larger power component. This is because of the increased iron losses due to the high-frequency rotor flux and also the superposition of the two fluxes traveling in the iron at different speeds. In addition to this the exciting current in the rotor causes copper losses which increase the no-load input.

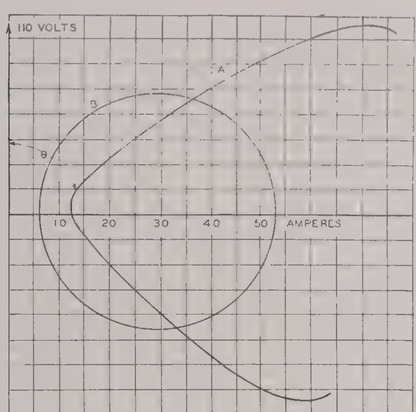


Fig. 6. Locus of line current

Curve A—Rotor and stator paralleled
Curve B—Rotor short-circuited

It will be noted also that the maximum power component of the input current is a little less than twice the maximum power component of the motor when its rings are short-circuited. This is caused by a slight terminal voltage drop with these heavy loads. It may be assumed that the heart-shaped diagram would have had a slightly higher maximum power component if the voltage had remained constant. The arithmetic sum of stator and rotor currents was almost equal to the line current.

The exciting current taken by the motor is indicated by the oscillogram of Fig. 7. It can be seen in Fig. 8 that some of the high frequency waves have pointed peaks and the other maximum values of the same wave have rounded points. This indicates a high saturation during part of the cycle.

When the machine is loaded, the high frequency currents and the low frequency currents are each slightly out of phase. This is caused by different constants in the rotor from those in the stator; *i. e.*, the ratio of stator inductance to stator resistance is different than the ratio of rotor inductance to rotor resistance. It also can be seen in Fig. 8 that the low frequency current is slightly less than the high frequency current in the same phase.

The effect of the low frequency currents upon the line will depend to a certain extent upon the ratio of the motor rating to the rating of the transformers supplying the load. It is obvious that if this ratio is large, the efficiency might be reduced.

It is possible to operate a wound rotor induction motor with its rotor and stator paralleled when the voltage ratio is not 1 to 1, by connecting the low voltage rotor to the high voltage line through an auto-transformer. The behavior of the machine under these conditions should be better than when no transformer is used, since the transformer will by-pass part of the low frequency current that ordinarily would flow through the supply transformers

The tests made on the machine as a motor and as a generator indicated two disadvantages of the parallel connection; the machine was noisy and the exciting current was high. This noise might be eliminated by special designing. Also due to the superimposed fluxes rotating in opposite directions the iron of the motor was saturated; this difficulty could be minimized by a special design.

Variations in the rotor and stator constants and in external resistances permit a number of combinations of motor characteristics to be obtained, including both high starting torque and good regulation. Also if the machine is to be subjected to a wide range of load, maximum efficiency may be obtained by the use of a switching arrangement in the rotor that will short-circuit the rings when the load is light, and connect the rotor and stator in parallel when the load is heavy.

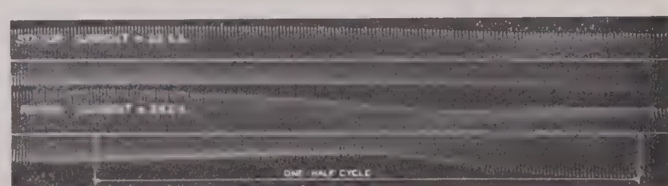


Fig. 7. No-load currents with rotor and stator paralleled 245 volts applied

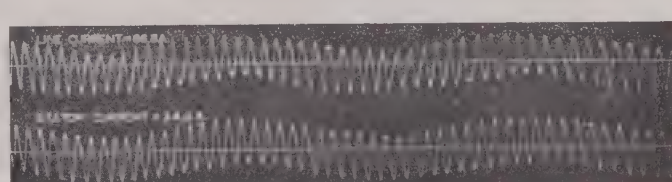


Fig. 8. Full-load current with rotor and stator paralleled 220 volts applied

Interconnection of Electric Power Systems

Companies with adjacent power systems are showing an ever increasing tendency to interconnect their properties. Supplementing previously published information, the following four articles classify and discuss the various interconnection services available.

INTERCONNECTION refers to the physical tying together of two or more independently owned or managed electric systems for the purpose of realizing financial benefits or improvement of service by the interchange of power and energy. The importance of linking power sources, transmission facilities, and load areas is fully recognized. Interconnection aids the electric utility industry in providing the customer with an electric supply adequate to his requirements in quantity, quality, and reliability.

In order to take full advantage of an interconnection, careful studies must be made, based upon a thorough understanding of the problems of each of the systems. The various factors involved first should be classified and defined so as to avoid confusion and error in comparing different schemes.

The subject of interconnection may be considered under the arbitrary divisions of (1) classification of service; (2) evaluation or economics; (3) contract; (4) design and construction; and (5) operation. The first two divisions, namely classification and evaluation, are considered by A. E. Bauhan in the first of the four articles immediately following. The second article, that by G. M. Keenan, discusses the development and operation of interconnected power systems, placing emphasis on the execution of a well formulated operating plan. The third article, by E. W. Dillard and W. R. Bell, enumerates the advantages as well as some of the disadvantages and difficulties in operating a particular interconnected system covering the more densely populated sections of New England. The last of the group, an article by H. S. Fitch, describes the plan of interconnection and operation of contiguous power systems independently serving a vast industrial region of Pennsylvania, Ohio, and West Virginia. In this case each system is under separate control, both financial and operating, with all the diverse standards and ideas of technical, commercial, and accounting nature.

Interconnection Services Classified and Evaluated

By
A. E. BAUHAN
Member A.I.E.E.

Public Service Elec. & Gas Co., Newark, N. J.

DETERMINATION of the economic merits of an interconnection, that is, its evaluation, is greatly facilitated by an orderly and logical classification of the services which that interconnection will render. Recognition of the various classes of service is not only helpful but is quite essential in the preparation and application of the interconnection contract, as each class of service requires different provisions and rates of payment. Such classification is helpful in rationalizing design, as for instance in determining whether the services to be rendered by the interconnection warrant a double or only a single circuit.

The classification offered here is not intended to be an enumeration of benefits rendered by interconnection but rather a delineation of the types of transactions which take place over interconnections. It is an attempt at earmarking or labeling the various amounts of power or blocks of energy in the light of what they do—of what service they perform—as necessitated principally by evaluation and contractual expression. Seven main service divisions may be recognized: emergency service, load diversity, firm power, storage power, intra-company use, economy flow, and unintentional flow.

Emergency service is the assistance which one company renders to another in the event of breakdown of equipment, unusual load demands, or other abnormal conditions resulting in power requirements in excess of the capacity of the normal power sources of the company in difficulty. When emergency service makes possible a definite recognizable reduction in the amount of generating capacity it is sometimes referred to as reserve diversity.

Based upon "Interconnection Services, Their Classification and Evaluation" (**No. 31-106**) presented at the A.I.E.E. summer convention, Asheville, N. C., June 22-26, 1931.

Load diversity refers to those transactions which result in a saving of generating capacity by reason of the non-coincidence of the times of the peak loads of the interconnected companies. For instance, if a system having a morning peak is interconnected with a system having its peak at 5:00 p.m. a saving in generating capacity results. If the diversity is found to be, say, 40,000 kw., each at the time of its peak could receive from the other 20,000 kw., thus realizing a saving of installed capacity of that amount. Three subdivisions of load diversity, daily, monthly, and yearly, are illustrated in Figs. 1, 2, and 3. The total diversity saving is equal to the daily diversity of the combined-peak day plus the monthly diversity of the combined-peak month plus the yearly diversity.

Firm power arises when one company, instead of installing necessary generating capacity in its own system, chooses to buy power from the other system. It involves a sale contract of either long or short term, with a firm obligation on the part of the seller to hold available capacity for the use of the buyer in lieu of installed capacity.

Storage power transactions involve the conversion of energy generated off-peak in one system into peak capacity in another system, through the medium of storage, usually the storage of hydraulic potential energy. There are two classes of storage power transactions; (1) pumped storage, by which relatively low-cost energy is used to pump water into a storage pond during off-peak hours; and (2) improved utilization of storage, in which generation during off-peak hours is substituted for energy which would otherwise be taken out of storage. In either case the stored energy is utilized at such a rate of discharge and at such a time as will create additional capacity values. Examples of storage power transactions are illustrated in Figs. 4, 5, and 6.

Intra-company use refers to interconnecting facilities used by one of the companies in place of other facilities which otherwise it would have had to provide for its own purposes. Interconnecting facilities which may thus be used include transmission lines and structures, substation equipment, tertiary windings in interconnection transformers which take the place of separate two-winding transformers, and rights-of-way. In some of these transactions energy for intra-company use is commingled with interconnection flows, and in such cases contractual arrangements are necessary to provide for their separation and to limit the intra-company use so that interconnection flow is not unduly hampered.

Economy flow occurs when energy used by one system and which could have been generated by that system is for the sake of economy actually generated by another.

Unintentional flow is included because it is desirable to consider deviations from the intended flow and inadvertent flows when none is intended.

Evaluation

Before decision can be reached as to whether or not a proposed interconnection should be installed, it is necessary to estimate and present its economies. The following is intended to indicate the general procedure and mode of attack to be used in evaluating a proposed interconnection.

Generating Capacity Savings—From the load data and operating characteristics of the systems it will be determined that certain capacity savings are to be realized by taking advantage of the various services which have been enumerated. For instance the availability of emergency service may make it possible to reduce the spare capacity from 20 per cent or 25 per cent to 15 per cent, or from 15 to 10 per cent; or, where without interconnection it had been thought necessary to have three spare generating units, with interconnection it may be decided that two units will suffice. If there is load diversity in the interconnected systems this results in a comparatively definite capacity saving. Similarly, the opportunity for storage power transactions yields a determinable capacity saving.

Capital Cost Saving—After the amount of capacity saved has been ascertained the resultant capital cost saving must be determined by applying appropriate

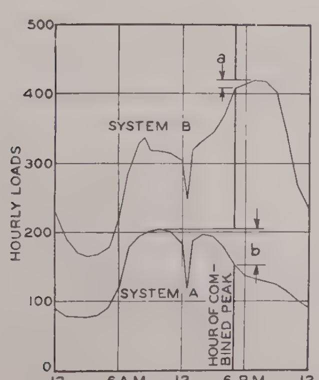


Fig. 1. Daily load cycle

Daily diversity = a + b

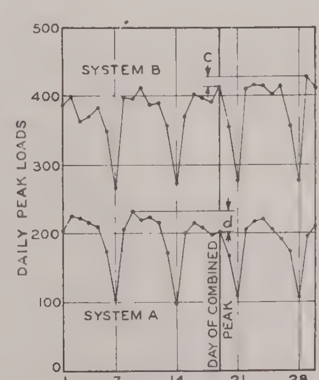


Fig. 2. Monthly load cycle

Month diversity = c + d

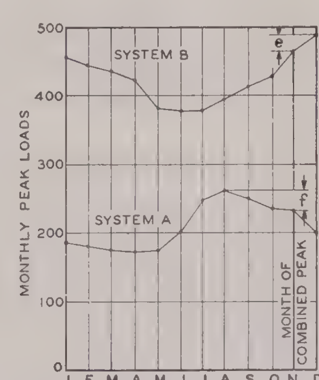


Fig. 3. Yearly load cycle

Yearly diversity = e + f

unit costs to the kilowatts of avoided capacity. If a more concrete study is being made, the particular year-by-year program of generating station investments "without interconnection" may be set up and compared with the "with interconnection" program. Any capital savings resulting from intra-company use of the interconnecting facilities or from firm-power transactions must also be taken into account. The total capital cost saving then is compared with the capital cost of the interconnection.

Annual Fixed Charges—Avoided investment naturally results in a reduction of generating station fixed charges. On the other hand, fixed charges are incurred on the interconnecting facilities. The term fixed charges ordinarily is meant to include the annual costs in money, insurance, taxes, retirement expense, and general expense; and in the case of facilities other than generating stations, it is sometimes convenient to include operation and maintenance expense. Usually they are determined and expressed as a percentage of capital cost.

The annual cost of money represents the compensation which must be given to capital to attract it to industry for the purposes under consideration. In the absence of abnormal conditions it is likely to be the prevailing allowable return on public utility property. Insurance, it should be remembered, includes not only premiums paid for all types of protection but also the cost of any self-insurance. Taxes can be determined only after careful consideration of the manner and the amount in which they are levied in each particular locality. Taxes levied on the gross receipts of the company ordinarily have no effect on interconnection economics. The necessity for including income taxes, with proper recognition of the effect of borrowed funds, must not be overlooked. Retirement expense should be determined on a sinking fund basis using the rate of interest earned on securities suitable for investment in trust funds. General expense includes administrative salaries, general office expenses, law expenses, relief and welfare work, etc. In some cases it may be considered that general expense will be unaffected by interconnection.

Naturally, no generally applicable fixed charge percentages can be cited. However, to indicate the order of the fixed charges it may be said that for steam-electric generating stations they frequently will be about 12 or 13 per cent, and for hydroelectric developments perhaps 9 per cent or 10 per cent. For steel tower transmission lines fixed charges are affected somewhat by the proportion of the investment in right-of-way, but they may be from 12 to 14 per cent with operation and maintenance expenses included. Substations, likewise including operation and maintenance expenses, will be somewhat higher; usually between 14 and 17 per cent.

Annual Production Expense Savings—After the saving in fixed charges has been determined it remains to evaluate the effect of interconnection on generating station production expense. This requires, first, determination of station load schedules with and without interconnection and, second, application of the individual station production expense formulas to the end that the changes in the fixed and variable elements of production expense be determined.

The output of each station and the character of its load for most economical conditions with and without interconnection may be obtained by resorting to integrated duration curves, or duration curves, for the loads of the individual systems on one hand and for the combined system on the other, on an annual, seasonal, or monthly basis, according to the degree of precision desired. Due allowance must be made for the outage of generating units for normal and abnormal mainte-

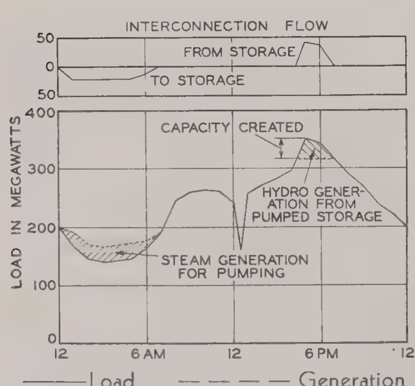
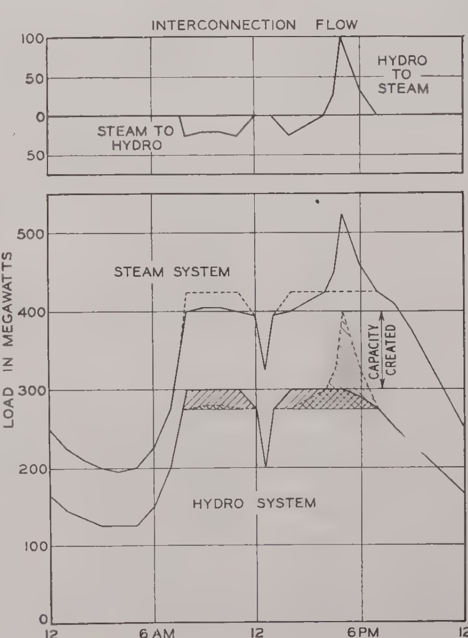
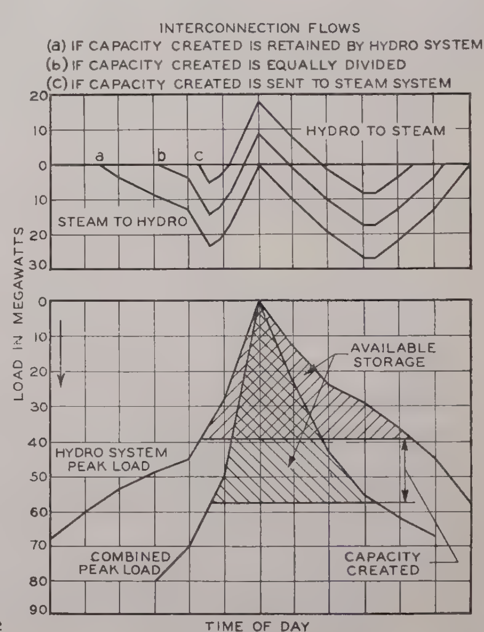


Fig. 4. (Above) Pumped storage

Fig. 5. (Middle) Improved use of storage on systems having dissimilar peak characteristics

Fig. 6. (Extreme right) Improved use of storage with similar system peak characteristics





nance. It must be remembered that the interconnection transactions will be limited by transmission losses, the capacity of interstation and interconnection transmission, the necessities of service protection in local areas, minimum steaming conditions, and the minor imperfections of operation and of contracts.

Before the production expense savings due to interconnection can be determined it is necessary to know the behavior of production expense as a function of station output for each generating station in the interconnected systems. For interconnection studies the two-part annual production expense formula has been found sufficiently accurate and most suitable. Derivation and use of this formula have been discussed in "Presidential Address to Junior Engineering Society" by Dr. John Hopkinson in Transactions of Junior Engineering Society (British) 1892, and reprinted in *Rate Research*, v. 2, 1912, p. 23-38; and in "Discussion of the Elements Entering Into the Cost of Producing Power" by W. B. Skinkle in *Iron and Steel Engineer*, June 1928, p. 278. Such a two-part formula arises from the experience that within a limited range of annual capacity factors the production expense is made up of a fixed element independent of annual output and a variable element directly proportional to the number of kilowatt-hours generated in the period.

Obviously the avoidance of generating capacity installation accomplishes a reduction in the fixed element of production expense. Approximately, and frequently with sufficient accuracy in the case of a long-term study, the saving in fixed element expense is the number of kilowatts of avoided capacity resulting from the interconnection transactions multiplied by a figure (for large steam stations possibly between \$3.00 and \$5.00) representing the fixed element of production expense per kilowatt of avoided capacity. Its effect is similar to avoided fixed charges.

The change in variable element of production expense involves only the multiplication of the energy quantities determined for each generating station with and without interconnection, by the corresponding increment cost per kilowatt-hour from the two-part formula and obtaining the difference between the two plans of operation. Frequently the net effect of interconnection on this item is not a saving, but a decided loss. The explanation of course is that the interconnection forestalls installation of modern, highly efficient equipment, and increases the duty on older plants having higher variable costs.

Net Savings—Net savings resulting from the interconnection are obtained from the combination of net fixed charge savings and net production expense savings, which may well be presented by means of a tabulation showing the amount of these savings for each year studied.

No attempt has been made here to show how savings may be divided between the interconnecting parties, since this is a matter for agreement between them. Nevertheless, it is a factor which may affect some of the items of evaluation, and certainly requires careful recognition of the equities for each particular class of interconnection service in the agreements relating to the project.

Interconnection Development and Operation

By
G. M. KEENAN
Fellow A.I.E.E.

Pa.-N. J. Interconnection, Hazleton, Pa.

SYNCHRONIZED electric supply systems function as a unit, all the component parts responding to variations in the load demand. Under the interest of single ownership this inherent unit characteristic naturally was recognized but through the screen of diverse interests of multiple ownerships in interconnection is not so clearly apparent. If the best economic results are to be obtained the development and operation of each part must be related to the development and operation of the whole unit.

How much coordination is required? Some believe that all the benefits of interconnection can be obtained only by developing and operating the system just as though it were all owned by one company. The trend in that direction is inevitable and the individual company's interests need not be submerged by such a procedure. Others believe all the practical benefits may be obtained with much less coordination; that continuing interconnection over greater and greater areas so complicates complete coordinating arrangements that they become economically unjustifiable, and that better results will be obtained by maintaining stronger company individuality. It generally is agreed, however, that there must be at least sufficient coordination to care for equities in established contracts and to avoid penalizing any of the participating companies.

Development of Interconnections

Coordination in development of the interconnected system usually requires cooperative planning of generating capacity, interconnected transmission, border line service to customers, and system operating facilities. The intention is to provide the economically right

Based upon "Interconnection Development and Operation" (**No. 31-119**) presented at the A.I.E.E. summer convention, Asheville, N. C., June 22-26, 1931.

electric supply system for the load areas served while so arranging the business relations between the ownerships as to share equitably the benefits between the customers and stockholders of the properties involved.

Generating capacity must be distributed economically among the various types of steam and hydroelectric stations strategically located in relation to the load requirements and properly correlated for the absorption of all available by-product power from irrigation, navigation, flood control, water supply and industrial development. There is no difference between this problem and that of a system under one ownership, except in the breadth of its scope and possibilities.

The interconnecting transmission system should be developed cooperatively to assure the economical utilization of the generating capacity and the reliable supply of electric service to load areas with sufficient operating flexibility in the system design to permit prompt resynchronizing when portions have been separated from the main system. The tendency is to increase transmission costs, and special effort is required to maintain the proper economic balance. Performance of interconnected loops is demanding more and more attention. Short-circuit current, stability, voltage regulation, and power flow in closed loops must be analyzed, and if necessary controlled by special equipment.

Service should be supplied border line customers in the most economical manner regardless of ownership, and the proper equities worked out between companies.

Planning of Operation

Cooperative planning of system operating facilities is essential as a result of the unit characteristics of the interconnected system. The men directing the operation must be provided with adequate facilities to show what is going on, to determine how the performance should be properly correlated and readjusted, and to take the necessary action to accomplish the results required. The objective in the operation of electric supply systems is to produce most economically the most reliable service possible with the system provided; at the same time, maintenance must be accomplished efficiently. The coordination of all operating and maintenance personnel and operating equipment on the system to bring about this objective requires careful planning and execution.

Interconnected system operation differs from system operation under single ownership only in the method by which the objective is accomplished and in the necessity of properly caring for the equities resulting from differences in ownership. Some interconnected systems have gone to centralized control just as have all corresponding systems under one management. Planning with centralized control requires assembling yearly, monthly, and weekly load and maintenance forecasts for the various systems in the interconnection, and consolidating them into one interconnected system forecast. Operating schedules are prepared, based on these predictions and with a complete knowledge of characteristics and costs of all fuel generating stations, as well as quantity and limitations of available hydroelectric and by-product power.

On interconnected systems where centralized direction has not been established each company carries through its own planning and then checks with adjoining companies. Knowing the costs of the blocks of generation above and below that sufficient to carry its own load, each company determines with its neighbor where load and reserve can be placed for greatest economy.

Execution of Operating Plan

An interconnected-system operator coordinates the performance of the individual companies in the execution of the operating plan where centralized direction is provided on the interconnection. The various company system operators do not report to the interconnected-system operator any more than a switchboard operator reports to a local system operator. Only such coordinating directions are given and received as are required to produce dependable, economical, unified operation; in neither case is there any need for loss of individual initiative or responsibility. The function of the interconnected-system operator in some cases is assigned by mutual consent of the companies involved to some one company system operator.

The interconnected-system operator keeps in touch with the demands made upon the system and the performance of the personnel and equipment in meeting those demands. His course is charted by the schedule of operation which has been prepared. He compares the demands which have developed with those predicted, and from his thorough knowledge of all elements of the system, adjusts the performance of equipment and personnel to compensate most economically and effectively for deviations of the actual from the scheduled demands.

Details of directing are so numerous that it is essential to develop a method of procedure which delegates as far down the line as possible, the detailed observation of indications and responsibilities for compensating adjustments. Direction is superposed only where coordination between the operating points is necessary. Every switchman, substation operator, and generating station operator usually is allowed to do all he can without coordinating direction from the local system operator of his area who, in turn, handles all he possibly can without coordinating direction from his company system operator. Methods of procedure and standard practise are established through written operating instructions reducing to a minimum the number of directions necessary for either emergency or normal operation. Complete and thorough training of all the operating personnel is essential to be sure that everyone

can be counted upon to respond as promptly as possible, and thus harmonize action over large areas even though the individuals do not know just what is being done simultaneously by other individuals.

When such a system is well established with well trained personnel, lightning storms and similar emergencies are handled satisfactorily without any one person knowing all that is taking place; in fact often it becomes necessary to spend some little time on assembled records after the emergency is over in order to determine what actually happened and whether or not individual equipment and personnel have functioned properly.

Most existing interconnections have no centralized direction. The system operators of adjoining companies coordinate the performance of their companies and by such action, progressing through the interconnected group, produce unified operation. In exactly the same manner, many companies have handled their own operation between the switchboard operators at two or three generating stations before justifying system operators. The effectiveness of the de-centralized method is increased by occasional meetings of those directing operation of the individual companies where operating problems and practises may be reviewed and a mutual agreement reached on methods of procedure.

In a closed loop interconnection without phase shifting transformers or other such equipment, it is impossible to direct the power flow. Adjustments can be made only for the individual company's conditions by so regulating that company's generation as to produce the net power flow desired. As yet no satisfactory method of accounting for equities in interconnected loop operation between several companies has been developed.

Little attention is paid to the power flow on tie lines in a system under one ownership until there is danger of reaching some physical limitation on the circuit. Power flow on tie lines between different ownerships in interconnection, however, becomes one of the bases on which money is exchanged; therefore it becomes a part of execution of the operating plan to sort out, classify, and account for the different classes of power flowing. Unless care is exercised in establishing principles not only in operation but in the contracts, this work is likely to become excessively complicated.

As long as the properties are synchronized so-called incidental or uncontrollable power will flow across the interconnection even though no power flow is scheduled. It is necessary therefore to have an incidental rate which will encourage complete utilization of the instantaneous diversity without penalizing anyone.

An encouraging emergency rate is necessary which will induce everyone to rely upon the interconnection reserve but which will at the same time adequately compensate those properties producing the power in emergency. The rate used for a sustained emergency must compensate the property supplying the capacity and yet not penalize too severely the companies using the capacity, unless the necessity for this use has arisen from negligence in maintenance, poor planning, and development or wilful leaning to prevent investment in capacity.

In interconnection as in democratic government the total benefits to be shared are in proportion to the total participation; and the regulation imposed on the individual participant should be the minimum which is necessary to make the benefits proportionally available to all.

Interconnection in the New England District

By
E. W. DILLARD
Member A.I.E.E.

W. R. BELL
Associate A.I.E.E.

Both of
New England Power Engg. & Service Corp., Boston, Mass.

COMPREHENSIVE interconnection of power generating sources has developed in New England largely because of the high load density and the economical combination of hydroelectric and steam-electric sources which have existed in this territory. The first ties were made somewhat prior to 1917 and were used to obtain steam relay power for hydroelectric developments, and to provide a market for surplus energy generated by water power. More recent ties have been made to permit also the absorption of large quantities of surplus steam-electric power from high grade steam plants and to pool resources by the sale of firm capacity in order that economical construction schedules might be obtained.

Benefits Derived

Interconnected companies not under a common financial control have not availed themselves of peak diversity to save capacity installation; each company has assumed responsibility for its own primary load. Although 5 per cent diversity amounting to say 50,000 kw. exists, this is utilized as a worthwhile safety factor, and the systems therefore are continually tied together even though kilowatthours are not exchanged. Between certain of the commonly owned groups, a larger di-

Based upon "Interconnection—New England District" (**No. 31-107**) presented at the A.I.E.E. summer convention, Asheville, N. C., June 22-26, 1931.

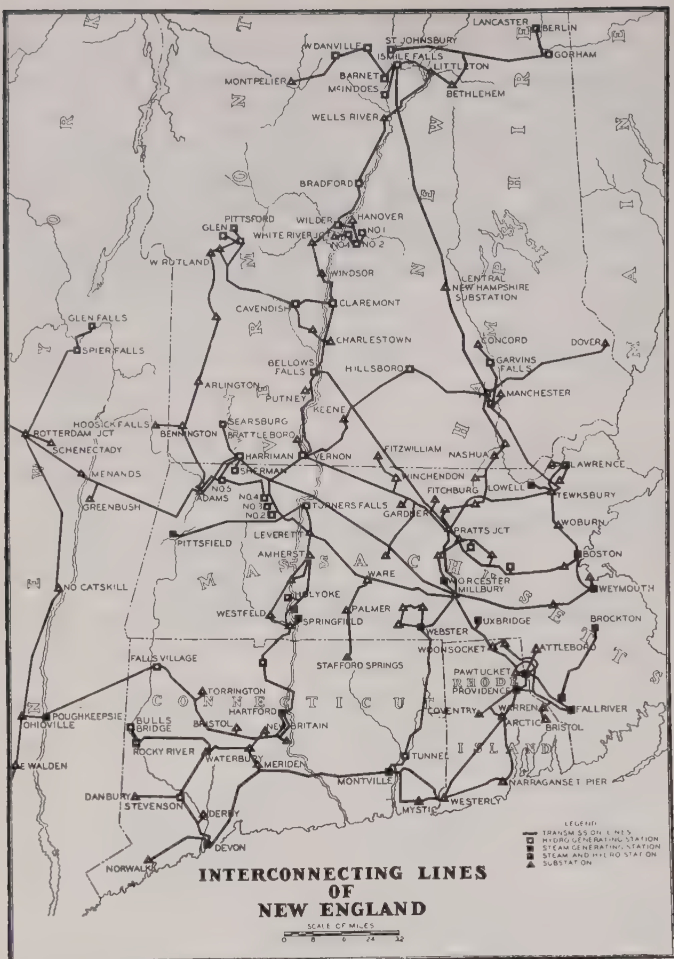


Fig. 7. New England interconnection

versity on the order of 7 per cent is utilized at a considerable saving. This diversity exists because of peaks occurring on different days of the week. On the interconnected system there is no large diversity due to differences in time.

No particular advantage is taken of reserve diversity. Individual companies usually carry spare capacity equal to that of the largest unit; interconnected systems usually carry about 10 per cent of their operating units as spare capacity. In general, it has been demonstrated that the loss of from 25,000 to 50,000 kw. on the system results in less than a 1/10-cycle drop in frequency.

Interconnected companies generally, as a matter of insurance, wish to keep tie lines closed as much as possible. There have been numerous instances in which tie lines have been valuable for emergency interchange upon the occurrence of apparatus failure, operating mistakes, and the like. Excellent relations exist between interconnected companies in such matters, and there have been but very few cases in which special charges were made for such services.

Low water is not classified as an emergency condition because all the major connected systems have water power sufficiently relayed with steam or purchased power. During various periods of fuel shortage, the New England power system, with the exception of the winter of 1917-1918, has been fortunate enough to obtain sufficient fuel for its own plants. It has taken advantage of interconnection by arranging to supply fuel to interconnected steam plants, in return receiving power at prearranged prices.

The use of interconnected lines for economy flow has shown large financial returns, and now, when surplus hydro power or economical steam is available, there is no operation of uneconomical plants excepting in some special cases where for special reasons there is a need of local generation. Almost all companies purchase power when it is to be had for less than local generating costs. The savings from major operations of this sort usually are split equally between the companies participating.

Contract Relations

Usually no contracts are drawn for other than the purchase of firm capacity, and each company builds the portion of interconnecting lines in its own territory. The interconnected companies of comparable size have established a definite system whereby, based on cost differentials and demands, the generating costs of connected plants can be determined, and interchanges are worked out daily. Under these exchanges there is no guarantee of service but when economic conditions shift unexpectedly it is customary for each company to continue its schedule until, with mutual understanding, adjustments can be made. It is customary also for all companies to assist each other in emergencies.

Plans for interchange usually are made daily, in advance so that definite schedules can be arranged late in the afternoon for the following day. The New England power system dispatcher is in touch with the dispatchers of the adjacent systems and determines the quantities of power which can be furnished or absorbed. These compared with his own sources and costs readily determine the economical set-up for the day, and schedules are arranged.

Disadvantages and Difficulties

One of the major difficulties that has arisen with interconnections lies in the inability to exchange an exact predetermined amount of power with a number of systems at the same time. Careful regulation of speed is of prime importance in this problem. Interchange has been controlled reasonably well by allowing one system to assume responsibility for speed control, each of the other systems taking care of the exchange over interconnections. Considerable work has been done in developing automatic frequency control apparatus which can hold speed much closer than the usual type of steam or hydraulic governor. This method of operation has a further advantage in the maintenance of more exact time for electric clocks.

Joint Planning of Construction

The New England power system has had the good fortune to have many alternatives in planning additional sources of power. There have been possible water-power developments of various types as well as a variety of methods of extending steam generating facilities. The development at Fifteen Mile Falls was of such size that it could not be justified without various interconnections to assist in its absorption. Its character is such as to make it a desirable adjunct to any system depending entirely on steam, and this made it possible to sell a large block of power to the Edison Electric Illuminating Company of Boston.

The New England power system load has grown to such a size that the capacity and power requirements for growth should not be studied as a whole but should be divided into three major classes: (1) base load; (2) power or day load of 2,000 hrs. per year; (3) peak and spare capacity. These various classes of load grow about equally on a percentage basis, but the short-hour or peak type of load grows far faster on a quantitative basis. Additional requirements of base steam of the best grade grow slowly, and if this type of plant is increased too far in advance of requirements, it crowds into short-hour use expensive plants designed for better load factor. For the second class, the day load or 2,000-hr. power, it is apparent that plant capacity should be secured for a lesser first cost than for class one. A few hydro possibilities are peculiarly suited to this service. If the hydroelectric plant site affords sufficient storage, permits the power house to be close to the dam, and does not restrict its size, the increment first cost of unusual capacity may be favorable. These conditions existed at the Fifteen Mile Falls development. The water available at this plant, though sufficient to operate at full capacity but 2,000 hours per year, can be used when it is most valuable, and involves a negligible operating cost for additional capacity.

The third requirement of the systems is a capacity suitable for meeting annual peaks and carrying through the year and during the peak period day-to-day spare. The necessity of this sort of facility has been well illustrated by the development of the Rocky River pumping plant of the Connecticut Light & Power Company. The Fifteen Mile Falls plant also is well adapted to supply this type of power. While the older and rather uneconomical steam plants also are suited to this type of service, the cost of being ready to serve for peaks and spare is higher than that of suitable hydro plants. The Fifteen Mile Falls type of plant will confine their use for this purpose to a very small part of the year.

Interconnection has made possible therefore a large development of power of decidedly the type needed on the New England system and which also fitted well into the Edison system but not feasible of development without a very large or interconnected system. It has made the entire output of this development more immediately useful and has put off the construction of further base load steam capacity, which in turn will be desirable of construction in large blocks or more economical absorption later in the combined New England systems.

Features of Design

Automatic frequency control apparatus has been installed at three hydroelectric plants on the New England power system in order that it may be possible during a great many hours of the year to have at least one of the plants in position to handle the burden of speed control. Different operating periods for run-of-river plants and storage plants require that automatic frequency control apparatus be installed in both types of stations to insure automatic speed regulation being available practically at all times without departing materially from the normal economic schedule of operation. It has been found that a frequency deviation of not more than 1/20 of a cycle from normal approaches the best possible conditions for load interchange.

The increasing interconnection of transmission lines, together with the increased use and reliance upon electric power, is necessitating always greater reliability and freedom from disturbances. In New England, disturbances originating from lightning present the most formidable problem in transmission line operation. Where justified economically, transmission lines in this district are being built with unusually short spacing of supporting structures to secure a low average height above ground; and overhead ground wires usually are provided. Horizontal construction with single circuit towers and two overhead ground wires are being used generally on all major lines. The natural condition of high footing resistance that obtains throughout New England has been overcome partially by steel grillages for tower footings. Considerable betterment in the performance of transmission lines has been secured by increased insulation and proper line location. Sleet is another formidable foe, and attempt is being made to design major lines to operate through the worst sleet conditions with not more serious troubles than broken conductors. Vertically spaced line designs generally have been abandoned. Considerable use has been made of sleet thawing.

As the result of high speed oil circuit breakers and high speed relays now being installed a considerable improvement in operating conditions is expected. The Fifteen Mile Falls development was equipped with 220-kv. circuit breakers having an over-all relay and circuit breaker operating time of the order of eight cycles (0.13 sec.) and it is hoped to secure similar characteristics in breakers purchased in the future for the lower voltage developments. Tests on the 220-kv. breakers, some of which were taken under actual operating conditions, showed the removal of short circuits in quite a spectacular fashion, with only very small voltage disturbances and a remarkable lack of damage at the point of application of the short circuit. Considerable

increase in synchronizing power during the short circuits also was secured.

Experience with this system indicates that the economical application of a high voltage interconnection necessitates such power factor correction as to insure the operation of the high voltage lines at practically unity power factor. Interconnected lines must operate also at a somewhat less drop in potential to avoid voltage variation when the point of feed is shifted on the system. Approximately 180,000 kva. of synchronous condenser capacity is in operation on the New England power system, and has proved justified on the basis of economy of transmission and voltage control. On the New England system there has been no occasion up to the present time that has necessitated the use of load ratio control for shifting load or balancing power between parallel circuits. No-load tap shifting devices have a widespread use on this system; their operation has been so successful that the New England companies were among the first to standardize upon external tap shifting devices for practically all important transformers.

Pa.-Ohio-West Va. Interconnection

By
H. S. FITCH
Associate A.I.E.E.
West Penn Power Co., Pittsburgh, Pa.

TEN INDEPENDENT operating companies of western Pennsylvania, eastern Ohio, West Virginia, and Maryland operate normally in parallel to secure the manifold advantages of the interconnection of their facilities. Each of the systems has had its own romantic growth from the small local generating plant to the highly developed load area with its network of power lines furnished by modern power stations. It was proper then that these independent neighboring companies should cooperate to realize the benefits of interconnection. These benefits now are being secured, the common understanding of every day problems of parallel operations being secured through the working committee of operating men from each of the ten individual systems.

The territory served by the ten operating companies constituting this interconnected system has an approximate total area of 101,000 sq. miles, and a population of about 9,000,000 including 300 cities and towns of all classes. An estimate of the peak load of this group for 1930 occurring in December between 9 and 11 a.m. is 1,750,000 kw.; the annual load factor is about 70 per cent.

Based upon "The Pennsylvania-Ohio-West Virginia Interconnection" (No. 31-103) presented at the A.I.E.E. summer convention, Asheville, N. C., June 22-26, 1931.

Contractual Relations

Reliability of service, capital investment economy, operating economy, and the stabilization of frequency, voltage, or reactive kilovoltampere conditions on transmission systems, are all represented on the contractual relations of these interconnected companies. Neighboring companies first contacted on the frontiers of their respective systems for the mutual protection of those districts having only one source of power. Ever since 1916 capital investment economies have been secured on these systems by the use of short-time contracts for the purpose of dovetailing the steps in power station building programs. In this manner, the economic waste that goes with building generating stations too far in advance of the individual system load has been eliminated by staggering construction between independent companies.

An example of the combined financing of power stations exists in the Windsor power station owned jointly by the Ohio Power Company and the West Penn Power Company. This station built jointly in 1917 produced all the major benefits of the interconnection of generating facilities as well as many other operating and investment economies. Combined financing of transmission lines also has been secured between the Associated Gas and Electric Company and the West Penn Power Company by working out a program whereby each company constructed sections of high voltage transmission line serving its own system and then tying in with other sections owned jointly by these companies. Five years of perfect cooperation have been the result of this unique arrangement.

A strong transmission backbone now exists throughout the ten interconnected companies, and the whole system is a fine example of how planning and operation can be accomplished safely with a much lower percentage in spare generating capacity than is possible without such interconnection. The reserve capacities are so distributed that what any one system will be called upon to furnish represents in many cases only the overload capacities of the machines in usual operation. Another factor, the protection of service based upon mutual assistance when necessary, is commercially the most important of all the possibilities of interconnection. Several instances of emergency have proved the benefit of this form of protection.

Operating Benefits

The study of the problem of reduction in spare generating capacity on this interconected transmission system has resolved itself into two phases; one, the

utilization of the operating or spinning reserve capacity of the generating units, and the other, the coordination of the operation of the reserve capacity between these various companies so as to carry the required spinning reserve in the most economical manner. The resultant diversity by combining spinning reserve capacities makes possible a decrease in the total reserve capacity in service without the loss of reliability, and the proper proportioning of the spinning reserve capacity between the component parts of the system materially decreases the amount carried on any one system. On this interconnected system it is believed that the spinning reserve carried by any one company should be 10 per cent of the load carried by a steam station and 5 per cent of the load carried by a hydro station. When any one company generates more than 20 per cent of its load on any one steam unit, it should carry as its portion a spinning reserve equivalent to 50 per cent of the load on this unit. Each of the two metropolitan systems serving Cleveland and Pittsburgh with their adjacent territories carries its own reserve, equal to the largest unit on its system. These urban systems follow the practise of holding this reserve only in the overload and less efficient capacities of the generating equipment actually in operation.

Windsor station, being the central point of the interconnected system, acts under supervision of the working committee as a clearing house for all data on existing reserve capacity. Any changes in spinning reserve capacity desired by one of the companies are transmitted to the Windsor dispatcher. In no case is the spinning reserve deficient for more than two hours. If an accumulation of circumstances causes the required spinning reserve to be decreased by more than 25 per cent, the Windsor dispatcher at once has a check made of all possible reserve, and if the actual spinning reserve is not equal to at least 7½ per cent of the then total system peak, he requests that additional capacity be placed in service at the most convenient location as soon as possible. Through the proper use of this reserve generating capacity the interconnection has wrought such wonders that the public is often unaware that trouble has ever occurred.

The tying together of small communities within the same system commonly results in a large saving due to load diversity; however, it has been found that the

Fig. 8. Transmission backbone of Pennsylvania-Ohio-West Virginia interconnection

interconnection of large systems does not produce this same diversity saving. A typical case is that of the western part of the interconnected system on which, with a system peak of 490,000 kw., the diversity between the four individual systems was only 15,000 kw. or 3 per cent.

The expected diversity between industrial and lighting loads cannot always be secured, as there are times when the evening peak of the groups serving essentially industrial systems approaches within 8 per cent of the morning peak. Also, the low water conditions prevailing since November 1929 create an evening peak for the steam stations. The diversity in the industrial load itself has increased noticeably during the last two or three years, no doubt due to the use of off-peak power by many industries. The difference in time between sections of the interconnected system is scarcely noticeable in the group as a whole.

Fig. 9. View of switchboard room and load dispatcher's headquarters at Windsor station

Stability

Installation of the 132-kv. transmission backbone and care in the selection of characteristics of equipment at the terminals, have caused instability to be no longer the serious problem that existed with earlier interconnections. As Windsor is the center of all interconnected operations, so is this station the center of the stability problem. The generators at Windsor are of the large air-gap type with a high short-circuit ratio, requiring a heavy no-load magnetization. Consequently with full excitation and no-load a low maximum voltage is indicated. These machines are not much affected by load changes and are inherently stable. The voltage regulators at Windsor are of the Tirrill type, one per exciter direct connected to its generator. From the standpoint of stability this arrangement of exciters is satisfactory, since steam units do not overspeed to any great extent. The voltage regulators operate in parallel through the usual compensating coils which force a correct sharing of the reactive kilovoltamperes. Automatic frequency control normally operates upon three units.

Throughout its history the Windsor station has stood like a rock against the many momentary surges transmitted to it from the east or the west. It has handled successfully many rapid load changes on the order of 50,000 to 90,000 kw. The problem of stability on each system is mainly staying in synchronism with Windsor.

East of the Windsor station a main transmission line extends 41 miles to Charleroi substation, from which a main transmission line extends south to the Lake Lynn hydroelectric station, and north to the Springdale steam-electric station. Most of the eastern parts of the interconnected system are tied in at these two last named stations. The synchronizing power of the lines between Windsor and Springdale, and between Windsor and Lake Lynn, is 500,000 kw., which is ample to hold these stations together. The generating units at Lake Lynn and Springdale have a low short-circuit ratio.

An unusual situation exists between two of the systems which are so tied together through autotransformers with dead-grounded neutral that either system may receive ground fault disturbances from the other. However, so far no difficulty has been encountered from these connections.

The most vulnerable point of this eastern system is near the Springdale station where there is a short-circuit capacity of 1,200,000 kva. Calculations indicate that a three-phase short-circuit fault must be isolated within 16 cycles or the units are likely to go out of step. A severe case of dynamic instability on the occurrence of a fault on both of the two 132-kv. lines near Springdale caused two generators to trip out on overspeed. Following this the excess voltage protective devices of the voltage regulators at Springdale were removed from service, and the subsequent occurrence of a more severe short circuit caused no generators to be tripped out of service.

In several instances the high power factor and low generator short-circuit ratios at Springdale have caused the operators to place a leading power factor upon a generator during load shifting, with the result that the generators fell out of step, without however interrupting service.

The interconnected systems to the west of Windsor station are somewhat more extensive and complex; certain of the lines form a 250-mile high voltage transmission ring involving five power companies with a total generator capacity of nearly 1,250,000 kw. Occasional operation with this ring closed on itself has demonstrated the inflexibility of interchange control, and therefore the loop is left open. Comparatively few cases of static instability has been reported on any of the interconnected systems.

The regulation of the flow of reactive power and the distribution among generating units is not a problem on this interconnected system. This is due largely to the high power factor maintained on lines and generating stations, made possible by the character of the load and the synchronous condenser capacity located at the transmission substations. On the systems of the West Penn Power Company and the Ohio Power Company alone there is synchronous condenser equipment totaling 172,500 kva. not including the generating units at hydroelectric stations which may be operating with low gate opening. The voltage of the generating units at the principal power stations is held practically flat, there being not more than a 3 per cent variation between light and heavy load. Load ratio control equipment is used to a limited extent to give control of the reactive current.

Frequency and Power Flow Control

Close regulation of the load among the interconnected systems of this group and among the individual power stations of each system has been a most difficult problem. It has been necessary for the working committee to hold many meetings to analyze these problems and determine a common basis for action. These meetings have been followed by continual educational work among the load dispatchers and switchboard operators until satisfactory operation has been accomplished.

Early in 1929 the working committee decided that Windsor station with six 30,000-kw. generators be assigned the task of holding a deviation from 60-cycle frequency of less than 1/20 cycle. As no automatic frequency control equipment had been installed, one operator on each shift was assigned to the duty of holding steady frequency by adjustment of the six governors. Operators in the other stations were instructed to disregard frequency entirely and concentrate on maintaining a close adjustment of tie-line load. The success of this new scheme of operation is indicated by the fact that whereas it had been the usual practise to adjust tie-line loads three or four times an hour, three or four times a morning, afternoon, or evening then sufficed.

In 1930 automatic frequency control equipment with an adjustment range of 0.25 cycles plus or minus was installed. Although arranged to control all six generators, it was found that with normal operation three or four generators were adequate to hold the system frequency to within 1/40 cycle of 60 cycles.

After a year's study of frequency regulation by Windsor station only, it was found that the only real difficulty of this scheme of regulation occurred at the periods of day when the load was shifting rapidly as at 7 a.m., the noon hour, and 6 p.m. Additional automatic frequency control equipment is now being experimented with at other stations. Preliminary tests would indicate that the objective has been achieved.

Forecasting Population for Engineering Purposes

Population forecasts, when carefully and intelligently made, serve a valuable purpose in helping to direct the employment of labor and capital to places or projects where they are most needed. Such forecasts cannot be based on formulas, but require careful weighing of many related factors.

By
J. N. HOLSEN
Southwestern Bell Tel. Co., St. Louis, Mo.

ENGINEERS and persons responsible for the management of engineering projects have a common interest in problems of forecasting population growth and market demands. The soundness of engineering projects depends upon their capacity to fulfil a real demand; unsoundness or even failure may result from planning and designing engineering projects without regard to industrial and population trends. Similarly, city planning, housing and home building projects, and educational and social programs of various kinds ordinarily should be based upon the number of people to be served at some future date and their economic and social characteristics.

Within the Bell System the careful study of factors influencing the growth, distribution, and character of the population is regarded as essential to the intelligent planning of the telephone business. Engineers are provided with forecasts of the probable telephone service requirements at periods ranging from five to twenty-five years into the future; on the basis of these and other pertinent factors, the initial and ultimate size of buildings, switchboards, underground cables, and the pole lines and aerial cables are determined. In planning for the future, the central aim of the telephone company is to supply the right amount of facilities in the right place. Manifestly this cannot be done except when based upon dependable forecasts of population and its distribution.

Several mathematical formulas have been devised on the assumption that future population can be determined from past trends by the mere application of figures in the formula. It is believed, however, that such formulas place too much emphasis upon past

Based upon "Forecasting Population for Engineering Purposes" (**No. 31-138**) presented at the A.I.E.E. South West District meeting, Kansas City, Mo., October 22-24, 1931.

trends, ignoring the fact that new influences are always appearing and that old influences are frequently ceasing to be of importance.

Cities and regions grow not from mere wishing or boasting, but usually because of definite geographic and economic advantages which enable them to develop population supporting activities in competition with other localities. Forecasts are apt to miss the mark rather widely if the forecaster has only a local point of view. A national outlook eliminates the optimism based upon the pride of those born or residing in the particular locality for which the forecasts are being made, and the conclusions reached by a broad point of view undoubtedly are much more likely to be realized.

Population of the United States as a Whole

Because communities are competing with each other, population forecasts for states and for individual cities should be made with due regard to population trends of the country as a whole. Some of the facts and tendencies that have a definite bearing upon the population growth of the United States may be summarized briefly as follows.

The United States is almost certain to continue a restrictive immigration policy for many years to come. Until the last decade, immigration contributed heavily to our population growth. This is clearly evident from the 1930 census figures which showed that foreign-born whites and their children constituted 31.1 per cent of the country's total population. In the future, population increases must depend more and more upon the excess of births over deaths.

The birth rate in the United States has been declining gradually for several years, due to such factors as generally higher living standards, smaller living quarters, marriages in which both husband and wife are breadwinners, the tightening of immigration restrictions against the prolific races, and finally wider knowledge and utilization of birth control information. Although there have been reductions in infant mortality, the effect has not been sufficient to prevent a decline in the rate of natural increase. For example, in 1910 the birth rate was about 30 per 1,000 population and the death rate was 15, while at present the birth rate is very close to 19 and the death rate about 12. Thus, in twenty years the margin which represents natural increase in population has decreased from 15 per 1,000 to 7.

The number of people in continental United States in the last forty-year period together with increases in each ten-year period is indicated in Table I.

The gain during the 1920-1930 decade exceeds by more than one million the largest previous gain, that occurring in the period 1900-1910, and it is 3.3 million in excess of the growth realized in the decade just preceding, that is, from 1910 to 1920, when the net immigration was 25 per cent greater and the rate of natural increase some 10 per cent higher. A partial explanation of this seeming inconsistency is in the probable greater efficiency with which the 1930 count of inhabitants was made. Furthermore, the period of counting for the 1910-1920 decade was some six months shorter than that of the 1920-1930 decade. It seems evident that the natural rate of population growth has been steadily slowing down, and that the same general tendencies will prevail over the next twenty years.

Trend from Country to City

Now the slackening in the rate of population growth for the country as a whole naturally will be reflected in the population increase to be divided among urban and rural communities. Unless a community is relatively better situated than in the past, it cannot expect to maintain its past rate of growth. This is emphasized by the increasing mobility of the American people who always have been peculiarly ready to move in response to economic activity. The development of improved means of communication and transportation and the rapid spread of comparative information have accentuated this mobility. Thus the real advantages or disadvantages of communities are likely to play a more important role than heretofore in determining their relative capacities to attract or to hold a population.

Urban population has been increasing at a far higher rate than rural population. During the past decade the increase in the rural population was 2.4 millions as against 14.6 millions for the urban centers. Whereas the 1900 census reported only 40 per cent of the population as urban, the corresponding figure in 1930 was 56.2 per cent. This tendency is related intimately to fundamental economic changes, including the capacity of the farms to maintain a rapidly increasing urban population, and the transfer to the cities of many labors that formerly were a part of farm work. Contributing factors lie in the tendency of our export trade to shift from raw materials to manufactured commodities, the increasing per capita demand for these products in this country as a result of the rising standard of living (a tendency that is temporarily obscured by the present general business depression). Further contributing facts are in the additional opportunities for untrained workers in the cities brought about by both the decrease in foreign labor supply after the drastic restrictions on immigration went into effect and by the unusual growth in the service industries.

Further scrutiny of the census figures indicates that in general the larger cities in the country are growing more rapidly than the smaller cities. Between 1920 and 1930 the total growth of the ten largest cities in the United States, including their suburban territories, accounted for approximately 40 per cent of the total population increase of the country. The entire group of cities of over 10,000 population obtained 68 per cent of the country's total increase; and if the suburban areas of cities of over 50,000 population were included, the proportion would be raised to 86 per cent. Not only

has urban population been increasing at a far higher rate than the rural population, but the tendency is one that probably will continue into the future.

Forecasting Population of a State

A series of economic surveys was made by the Southern Bell Telephone Company between 1924 and 1930 with a view to providing a more or less definite picture of economic conditions and trends in the five states in which it operates. The general plan of these studies involved an analysis and presentation of the following subjects:

1. Natural features, including a study of land form, soils, climates, vegetation, and water resources, with respect to their influence on activities.
2. The situation and outlook of each state's basic industries—agriculture, manufacturing, lumbering, and mining—in relation to population.
3. The comparative conditions and prospects in the various natural or economic-geographic regions of the particular state, the regional treatment being essential because of the dissimilarity of conditions prevailing over most states.
4. A detailed analysis of the situation and outlook of the principal cities.
5. The effect of the probable population changes upon the demand for telephone service.

Illustrative of the kind of questions for which answers were sought by the state economic surveys are these: How will the expansion (or perhaps contraction) of agriculture be distributed over the state? Will farmers have a greater or lesser purchasing power? What is the manufacturing outlook in the state? What kind of manufacturing activities may be expected to expand and what about their localization? Will the increase in the population-supporting activities be sufficient to cause the state to attract large numbers of persons from other states?

Personal inspection tours of each state were considered essential, following the collection and careful review of such information as was available. Contacts had been established with organizations and bureaus throughout the area, and during the inspection trips interviews were possible with persons in many lines of work. Of course all of the material and suggestions gathered in this manner could not be accepted at face value since local pride and enthusiasm were not always restrained.

Forecasting the Population of a City

By the nature of things, no two cities present situations precisely alike; indeed, one of the most striking facts is their dissimilarity. However, in analyzing the past growth of a city and forecasting its future, there are usually five principal influences to be considered:

1. Size and character of its tributary trade territory
2. Its industrial expansion
3. Its attraction as a home center
4. Governmental activities
5. Institutional activities

Table I—Continental United States

Year	Total population	Increase during previous decade: Number	Per cent
1890 (June 1)	62,947,714		
1900 (June 1)	75,994,575	13,046,861	20.7
1910 (April 15)	91,972,266	15,977,691	21.0
1920 (January 1)	105,710,620	13,738,354	15.0
1930 (April 1)	122,775,046	17,064,426	16.1

Study of the trade territory of a city is essential to an analysis of the population supported or likely to be supported by the wholesale, retail, and general office business of a city. This territory usually can be defined with the aid of an analysis of banking relationships, newspaper circulation, and the distribution of sales of representative wholesale establishments.

The trade territory of practically every city is changing, increasing or decreasing in extent and also undergoing changes in the character of the population. In respect to the latter, it should be remembered that the importance of a trade center depends not only upon the number of people in the tributary area but also upon their standard of living. In an analysis of the probable future changes in the trade territory of a city, consideration must be given to the trend in agriculture and industry, including such factors as improved highways, motor trucking, and changes in freight rates.

Industrial Expansion

It now appears that the growth of most of our cities during the next twenty years will be due primarily to their relative attractiveness for industrial expansion. For purposes of population analysis, it is helpful to classify industries. They may be grouped according to those which attract population, such as steel mills and automobile factories, and those which result largely from the presence of population, such as bakeries, laundries, and ice cream factories. Again, it is helpful to consider industries from the standpoint of whether they are conservative or exhaustive in nature; that is, whether their supplies are continuous or temporary. The lumber industry as it has been carried on in this country is a striking example of an exhaustive industry; in many places, industries (such as oil refining) based upon the presence of minerals are exhaustive.

If a city has diversified manufacturing plants, its growth is likely to be more uniform or stable than for a city where a single industry is dominant. It is well to note that different industries do not contribute to the population of a city in exact ratio to the number of employees. In a number of industries including the manufacturing of shoes and clothing a large proportion of the workers are girls and women, representing second and third members of a family. Further, one must consider the effects of labor-saving machinery. In the

past virtually all industries have been able to increase their output by the application of labor-saving devices without a proportionate increase in the labor required, and it is certain that this tendency will continue.

There are many people who choose a place to live rather than a place to work. Among these are the independently wealthy, the retired, and the adventurers. These people seek living conditions to meet their desires, and adjust their occupations if necessary to what is attainable where they choose to live. The classes who seek places to live first and occupations afterwards are likely to increase in the future.

The national capital and many of the state capitals owe their growth primarily to the activities of the federal or state governments. In the past there has been a general tendency to enlarge the functions of governments, but for the immediate future it seems reasonable to expect an increasing pressure for more economical governmental administration expansion.

Effects of Institutions

Many cities in the country have military establishments, educational institutions, penitentiaries, etc., which add considerable numbers to the population. Sometimes institutions of this character are relatively so large and subject to such wide fluctuations in size that they tend to render past rates of growth of the city misleading, and to make forecasting of the future extremely difficult. In analyzing the population growth of such cities it has been found advisable to isolate the past population related to institutions and treat this influence separately in forecasting the future.

Many cities possess the advantages just described in more or less equal measure, yet their past and prospective rates of population growth vary widely. It is here that well-directed effort on the part of various civic bodies is important. The community which effectively advertises its natural advantages of location is likely to grow while a neighboring city equally well situated may stand still or even decline. Civic spirit is therefore a proper consideration in every population forecast. Through advertising activities a few of our cities have attracted a larger population than they can hold, and the slump which is bound to follow will perhaps permanently injure them. On the other hand some cities probably have retarded their growth by advertising which so glaringly exaggerated their attractiveness that their real advantages were overlooked.

In the telephone business, and in most other businesses where advance planning is required, it is important not only to know the probable growth of population, but also its character and distribution, and its division into family units. Future population growth is forecast upon the basis of certain definite factors already cited, including expansion of industry or commercial activities which support population. In estimating the amount of population that probably will be located in high grade, medium grade, and poor sections of the city, it is essential to know rather definitely the class of population supported by the various activities. Further, it is well to note that each part of a city is in competition with other sections of the city for the limited population growth of the whole community in much the same manner as cities compete with each other.

Abstracts

Of Papers to be Presented at the Milwaukee District Meeting

INTERPRETIVE abstracts of all papers to be presented at the A.I.E.E. Milwaukee District meeting (March 14-16, 1932) are presented herewith. Members vitally interested and wishing to obtain immediately pamphlet copies of any available papers are requested to use the order form appearing on p. 222 of this issue. In response to popular demand and within its space limitations Electrical Engineering subsequently may publish certain of these papers, or technical articles based upon them.

A General Method of Gaseous Tube Control

By C. Stansbury[2]

METHODS devised for the purpose of controlling the mercury vapor rectifier tube by means of the hot cathode grid have been produced in much profusion for the past several years. However, certain novel control methods which it is felt are based upon fundamental ideas and should be of general engineering interest are presented in this paper.

It is shown that the inherent rectifying property of the cathode grid circuit lends itself to condenser-energy-storage methods of grid control which may take a number of forms. A typical set of

control characteristics for a tube of the type described is shown, in connection with which it is pointed out that the response to grid voltage varies rather widely at different temperatures of the condensed mercury in the tube, except for anode voltages in the neighborhood of that at which the tube just starts with zero grid potential. This anode voltage is quite constant except at tube temperatures outside the normal working range, so that methods of control which take advantage of this fact give response comparable in accuracy to that of the high-vacuum tube. Various control circuits based on these principles are shown and described. (**A.I.E.E. Paper No. 32M6**)

The Proximity Effect and Its Application to the Concentration of Heating Currents in Predetermined Strips

By Edward Bennett[1]

IN ANY industrial operation such as welding, concentration of heating currents in particular parts of the metal presents obvious advantages. A method is described in this paper of concentrating these heating currents in predetermined strips of conducting plates, pipes, or other shapes. These are placed in close proximity to each other or to auxiliary conductors. They are so interconnected that heating currents concentrate largely in adjacent strips in close proximity to each other and in which the current flows in opposite directions. The shapes are connected with sources of alternating or oscillatory current of moderately high frequency. The method therefore consists in the use of an enhanced "proximity effect" to control the distribution of heating currents in bodies.

Mathematics and theory to assist in the solution of this problem are presented in the paper. Curves have been worked out to illustrate the control of the distribution of the heating current densities by means of this proximity effect. Unquestionably the control of the distribution of heating currents which is thus made possible opens up a new range of industrial heating effects. The method of selectively heating bodies by causing the heat energy to be generated in the body in strips of predetermined width and depth would seem to give a hitherto unattainable nicety of control of the distribution of temperatures in metallic bodies. (**A.I.E.E. Paper No. 32-54**)

Electrical Instruments in the Gas Industry

By E. X. Schmidt[2]

OPPOSITION to the use of electrically operated devices in the gas industry has disappeared because of the outstanding advantages of many forms of electrical control apparatus. Although the control of gas pressure generally is still mechanical, the flexibility and sensitiveness of electrical pressure controllers has made these devices a valuable asset in the distribution of gas. Thermal meters, calorimeters, and total heat meters are among those to which electrical devices are applied. The Thomas thermal meter makes possible the automatic measurement of gas flow at standard conditions independent of variations in the temperature, pressure, and saturation condition of the gas. The Thomas calorimeter, a device comprising an unusual combination of mechanical and electrical parts, provides a means for recording gas quality; while the Thomas total heat meter, an electrical combination of the above instruments, gives a direct measurement of the energy in the gas.

Heating values within 1 per cent, plus or minus, of a fixed value generally must be maintained. Therefore a calorific instrument designed for control purposes was developed. It is particularly useful for the automatic control of mixing two or more gases of unlike heating value to obtain a mixed gas of constant heating value.

The most recent development in the gas industry is the fully automatic gas plant for small communities. These plants are electrically operated and controlled, providing an uninterrupted supply of gas of constant heating value at constant pressure, a service which compares very favorably with that formerly enjoyed by large communities only. (**A.I.E.E. Paper No. 32M10**)

Toll Switching Plan for Wisconsin

By W. C. Lallier[3]

DEVELOPMENTS of telephone plant and technique have extended constantly the distance over which it is technically possible and commercially practicable to furnish toll telephone service. The result of this extension in the range of transmission has been to increase the number of possible commercial toll connections and to stimulate growth in toll service. In this paper, the toll switching plan for Wisconsin including some features of the transmission design requirements and the present and proposed toll cable network is outlined briefly. The relationship of the plan to that for handling countrywide toll connections also is touched upon.

It is found that the toll cable type of facilities gradually is supplementing or replacing the open wire type along many of the important routes of the system. It is expected that ultimately the use of open wire lines will be limited largely to the feeder and branch routes to cities and towns located some distance from the main toll cable route. A large majority of the principal open wire lines in Wisconsin now are arranged to have superimposed carrier systems operating upon them, and this application has been an important factor in providing for the increased toll traffic during the last few years. (**A.I.E.E. Paper No. 32-55**)

Police Teletypewriter Communication

By R. E. Pierce[4]

POLICE organizations throughout the country are rapidly adopting the latest development in record communication, namely, the teletypewriter. By this means alarms are typed at one point and simultaneously recorded in printed form at a large number of widely separated stations. The engineering for a modern police system involves not only the provision of the teletypewriter machine, but large networks of telegraph circuits with the associated switchboards, telegraph repeaters, power plants, and testing equipment which also must be designed, manufactured, and installed.

In adapting the teletypewriter to police work, some interesting problems have arisen. Usually service is of an intermittent

1. University of Wisconsin, Madison.
2. Cutler-Hammer, Inc., Milwaukee, Wis.
3. Wisconsin Telephone Co., Milwaukee.
4. American Tel. & Tel. Co., New York, N. Y.

nature and special arrangements are provided at the sending location for starting and stopping the distant teletypewriter. Also specially designed control arrangements are provided to allow an operator at general police headquarters to take control of an entire state network, including all groups of stations which normally would operate individually. In other cases an acknowledgment circuit is provided for advising the sending operator when a message has been received at a particular station. In certain types of offices where a number of stations is on one circuit, selective calling devices allow any one station to select any other station or group of stations on the circuit. Various types of leased networks are designed to fit particular needs of police organizations. (**A.I.E.E. Paper No. 32M8**)

Weather Resistant Insulation for Line Wires

By C. F. Harding[5] L. L. Carter[5] J. W. Olson[5]

GREAT ADVANCES have been made in the art of producing insulation for higher voltage cables, but it is only within the last two years that any unified and organized attempt has been made to improve the weathering and insulation qualities of the covering of weatherproof line wire. The relatively high cost and poor operating performance of weatherproof coverings on overhead lines of 4,000 volts and less, indicated the necessity for taking steps to improve the weatherproof covering or to discontinue its use entirely.

Complete testing equipment for determining the comparative life of different weatherproof wire covering was purchased or constructed for the laboratories at Purdue University. This very complete equipment has enabled a large number of conclusions to be drawn, the most important of which may be summarized briefly as follows:

1. The present triple-braid weatherproof wire covering may be improved materially by the use as saturants of higher fusing point blown asphalts, free of waxes and low boiling fluxes. Such a saturant will provide a covering of uniformly long life.

2. That the higher saturating temperatures required to apply such saturants may be used without damage to the cotton yarns or excessive annealing of the copper conductors, has been proved.

3. Specifications for weatherproof coverings soon will be written as a result of this work, the terms of which will guarantee weatherproof wire of long life.

4. Future work will provide a covering of lighter weight and smaller size, but of higher insulating value and longer life than does the present construction. (**A.I.E.E. Paper No. 32-56**)

Development of the Waukegan Station of the Public Service Company of Northern Illinois

By J. L. Hecht[6]

REASONS for the choice of site, general plan, and development of the Waukegan station are outlined briefly in this paper, further details being given in a companion paper by E. C. Williams. This station, located approximately 40 miles north of Chicago and on the west shore of Lake Michigan, has an installed capacity of 290,000 kw. It performs the dual function of supplying energy to a metropolitan system and a surrounding transmission system.

Following a careful study, the Waukegan site was acquired by the company in 1917, and subsequent developments have proved the desirability of this location. The first development period for the station was between 1922 and 1925, and consisted of a 25,000-kw. unit and a 35,000-kw. unit, both operated at 350-lb. pressure, with a total temperature of 675 deg. fahr. with no reheat.

During the second development period, between 1927 and 1930, a 50,000-kw. unit and a 65,000-kw. unit were added, the operating steam pressure being raised to 600 lb., with a total temperature of 725 deg. fahr. In the third period, just begun, a 115,000-kw. unit was placed in service September 1, 1931. At this time radical changes in switching arrangements were made. Considerable increase in the size of the station is anticipated for the future. (**A.I.E.E. Paper No. 32M9**)

Electrical Design Features of Waukegan Station

By E. C. Williams[6]

DEVELOPMENT of the Waukegan station through the three periods outlined in the companion paper by J. L. Hecht is described in the present paper. Details of the changes and the reasons for them are given.

The tendency toward metalclad switchgear in the development of this station is especially striking, the first 132,000-kv. switchgear of this type ever used having been placed in service as part of the installation for generating unit 5. This generator and its transformer operate as a unit without connection to the low voltage bus.

A number of interlocks on the switching and instrument transformer equipment is provided to prevent operating errors and to protect personnel. Also in designing the control and protective system for the automatic combustion-control equipment used with pulverized coal, unusual care was necessary to insure successful operation. Excitation equipment for the generators was designed to give economical and reliable operation. The paper outlines carefully the changes in practise, the novel applications of standard a-c. motors, the trend toward equipment providing greater safety for the operating personnel, better investment economics, and greater facilities of installation that have occurred at Waukegan station over a period of ten years. (**A.I.E.E. Paper No. 32-57**)

115,000-Kw. Turbo-Alternator

By R. B. Williamson[7]

DUE TO the increasing use of large single-shaft steam turbine units, it has been necessary to design very large generators operating at 1,800 r.p.m. The present paper describes a 115,000-kw. unit recently placed in operation. The generator is wound for 18,000 volts and the whole output of the machine, with the exception of a small part used for the operation of auxiliaries, is stepped up to 132 kv. All switching is done on the high voltage side of the transformers. Therefore it was possible to design the generator for a voltage that would permit a simple two-conductor per slot winding.

Because of the great axial length of the machine, ventilation required careful study, and a new scheme of rotor ventilation was

5. Purdue University, Lafayette, Ind.

6. Public Service Co. of Northern Illinois, Chicago.

7. Allis-Chalmers Mfg. Co., Milwaukee, Wis.

developed to secure uniform cooling throughout the length of the long rotor body. The stator ventilation is of the inward-outward parallel-flow type with fourteen parallel paths in each half of the stator.

Air circulation is provided by four single-inlet motor-driven blowers mounted under the generator. A fin type radiator cooler is mounted under the generator yoke and condensate is circulated through the cooler. Excitation is furnished from a 350-kw. 250-volt coupled, shunt-wound exciter, and a 7½-kw. overhung pilot exciter is used for the field of the main exciter. (**A.I.E.E. Paper No. 32-58**)

The Mercury Arc Rectifier Applied to A-C. Railway Electrification

By
O. K. Marti[7]

THE BASIC principle of grid control used in connection with large mercury arc power rectifiers is reviewed briefly in order to explain a new application of rectifiers which was made possible by these improvements. This application is described, and it is shown how by its use a single-phase motor for a-c. railway electrification service with series-motor characteristics and for use on any commercial frequency can be designed. With the grid-controlled rectifier it was found possible to eliminate the commutator of the motor and practically all the expensive controlling, switching, and reversing equipment commonly used on a-c. locomotives. The data and layout of a 1,000-hp., 50-cycle, 15,000-volt, single-phase locomotive are given.

The experiments carried out on a locomotive with this type of motor have demonstrated the practicability of the scheme. Besides the advantages from the point of view of locomotive operation, this scheme makes it possible to use a power supply of any available frequency, whereas at the present time frequencies of 25 cycles or less generally are required. While it is too early to predict to what this development may lead, the already apparent marked advantages of a locomotive equipped with this type of motor, may revolutionize the practise of railway electrification.

Mercury Arc Rectifier versus Rotary Converter Automatic Railway Substations

By
O. M. Ward[8]

EXPERIENCE in the operation of unattended, automatic, mercury arc rectifiers and rotary converter substations supplying 600-volt d-c. energy to overhead trolleys in interurban territory is discussed in this paper. Operating records covering a three-year period from November 1, 1928, through October 31, 1931 are presented for three mercury arc rectifiers, and two rotary converters of comparable size and operating under similar conditions.

As these rectifier stations were among the earliest installations with full automatic control in unattended substations, while full automatic rotary converter substations have been in service many years, it is manifestly unfair to compare these two types of stations for the first year or two of operation. Decided improvements have been made in rectifiers, and the 1931 record therefore may be assumed to be more indicative of normal performance. On this basis the records show that under conditions of operation existing in the Milwaukee interurban territory, the following conclusions may be drawn.

1. There is practically no difference in operation and maintenance costs of the two types of converting equipment, taking into consideration the higher efficiency of rectifiers.

2. Service availability of rotary converters is slightly higher than service availability of rectifiers when the converting equipment is unattended and equipped with automatic control.

3. Rectifiers have not been responsible for complaints from telephone companies or radio users.

4. Control system failures in whole or part are vastly more serious in automatic than in manually controlled stations.

5. More attention should be given to auxiliary relays, operating coils, protective equipments, etc., used in automatic control systems, to insure against faults in them. (**A.I.E.E. Paper No. 32M7**)

8. The Milwaukee Elec. Ry. & Lt. Co., Milwaukee, Wis.

The 60-Cycle Primary Transmission System of the Milwaukee Electric Railway and Light Company

By
C. D. Brown[8]
E. W. Hatz[8]

THE PRIMARY transmission system described in detail in this paper operates at 132 kv. and 66 kv. to transmit bulk energy from generating stations to step-down substations, and to interconnect the system of the Milwaukee Electric Railway and Light Company with hydroelectric plants in the northern peninsula of Michigan. The system is divided into power areas which are served directly from a generating station or from a step-down substation located near the load center of the area. Energy is distributed from these points over secondary transmission lines.

Tower lines are constructed where feasible on existing right-of-way of the electric railway system. High voltage lines are brought into the congested portion of the city over private right-of-way. Four types of tower line construction have been developed, three of which are used in special cases where lines are constructed on a railway right-of-way not sufficiently wide enough to permit the use of standard square base towers. This construction permits the conductors to be carried over the operating tracks of the railway system. The particular type of tower to be used is a question of economics determined by the cost of real estate at that particular location. The system is so planned that it is capable of indefinite expansion without major changes in existing equipment. (**A.I.E.E. Paper No. 32M3**)

Insulator Sparkover

By
W. L. Lloyd, Jr.[9]

SPARKOVER strength of the various parts used for the insulation of modern high voltage transmission systems has been subjected to a detailed study, the results of which are presented in this paper. Line and station insulation, and bushings used on the station equipment, were subjected to tests to determine their sparkover strength under a wide variety of conditions.

Data are presented for both 60-cycle sparkover and lightning sparkover voltages, and all values have been corrected to an air

9. General Elec. Co., Pittsfield, Mass.

density of unity. Considerable attention has been devoted to the effect of humidity and a number of interesting results have been obtained. These are shown in a group of tables and curves presented in the paper. Considerable data also are presented on the effect which smoke, steam, dew, fog, rain, and surface dirt and moisture have on the sparkover voltages of insulators. (**A.I.E.E. Paper No. 32-59**)

An Improved Type of Limiting Gap for Protecting Station Apparatus

By A. O. Austin[10]

A COMPARISON of the impulse flashover characteristics of various forms of protecting gaps and of station insulation shows these characteristics to vary widely for different degrees of overpotentials. In the usual type of protecting gaps, little or no provision has been made for adjustment in order to have the arcing characteristics of the gap conform to the insulation for the range of transients encountered in practise.

A new form of protecting gap, the polarity and time lag characteristics of which can be adjusted over a wide range has been developed, and in this article is compared to the usual form of protecting gaps. The advantages of this improved type of gap in providing protection for a wide range of transients, and at the same time reducing unnecessary discharges of the gap to a minimum, are shown by tests wherein the effect of time lag is quite evident. The advantage of equipping the protecting gap with a fuse or other device is more apparent where a lightning arrester is not present to take most of the discharges.

The advisability of using a limiting gap to protect station apparatus from flashover under very severe overpotentials, in combination with a lightning arrester to relieve equipment of the majority of transients of lower magnitude, is suggested as a means of providing increased protection, at the same time reducing interruptions to a minimum. The use of the control type of protecting gap is proposed as a means of more easily coordinating station insulation on new as well as existing installations. (**A.I.E.E. Paper No. 32-60**)

Design and Ecomomic Selection of Suspension Insulator Assemblies

By J. J. Torok[11] C. G. Archibald[12]

A SUMMARY of data from extensive impulse and 60-cycle laboratory flashover tests upon suspension insulator strings relative to unit shell diameter and unit spacing is given in this paper. The insulating qualities and the economic advantages of the various sizes of units are discussed with due regard to the most recent lightning protection theories. Consideration is given to insulation for high voltage transmission lines of both the steel tower and wood pole types.

Based on this study, the following conclusions may be drawn:

1. The major factor of steel tower transmission line design is the shielding of the power conductors with properly located ground wires and maintaining the tower footing resistance as low as possible.

2. For towers of low footing resistance, on the order of 20 ohms, the wave is of short duration so that the minimum flashover voltage of the attached insulation corresponds to its breakdown voltage at 2 microsec. with a flat-topped wave.

3. In applying insulation to well protected high voltage lines, suspension insulators should be judged by their impulse flashover characteristics at 2 microsec.

4. The choice of insulation for lines not protected, or inadequately protected, by ground wires is based upon impulse flashover values at long time lags of the order of 10 to 50 microsec.

5. Impulse flashover space effectiveness of suspension insulators improves with increase in unit shell diameter at moderate spacings.

6. Impulse flashover space effectiveness for all unit diameters falls off with increase in unit spacing.

7. Flashover space effectiveness decreases with increase in string length.

8. The cost for a given impulse flashover voltage generally is lower for larger diameter units and higher for larger unit spacings.

9. Available service data and laboratory tests show that the 12-in. unit is as serviceable as a 10-in. unit. (**A.I.E.E. Paper No. 32-61**)

Normal Frequency Arcover Values of Insulators as Affected by Size and Humidity

By H. A. Frey[13] K. A. Hawley[13]

DATA covering the electrical characteristics of comparable insulators, as received from different sources, are frequently conflicting and a study has been made therefore to establish rules whereby such characteristics can be estimated with a reasonable degree of certainty from the dimensions of the insulators. A long series of carefully made tests are summarized in the accompanying table.

Kilovolt Flashover Values Per Inches Arc Length

Insulator Type	Dry Value	Wet Value
Suspension		
0 to 100 inches		
Standard cemented	10.5 to 9	7 to 6.8
High strength cemented	10.5 to 9	7 to 6.3
Hewlett flat disk	10.5 to 9	7.5
Hewlett fish tail	10.5 to 9	6.5
Pin types		
Small	14	7
Multipart	14 to 11.4	8.9
Apparatus insulators	11 to 7.3	8 to 5.7
(Dry 0 to 110 inches)		(Erratic)
Equipment bushings		
Solid type	13.6 to 6.75	8.3
(With bare conductor)	12.4 to 6.1	8.3

Where two figures are given, the first applies to small insulators and the second to the larger insulators. In addition the ratio of wet flashover values in kilovolts to the wet striking distance in inches was found to be from 14 to 10.6 for high strength cemented suspension insulators, erratic for multipart insulators, and 13 to 10.4 for apparatus insulators. It was found that for dry arcovers the humidity correction per 0.1 in. mercury water vapor pressure was 2 per cent for standard cemented suspension insulators, apparatus insulators, and solid type equipment bushings; and 3 per cent for small, multipart, and pin type insulators. (**A.I.E.E. Paper No. 32-62**)

10. Ohio Insulator Co., Barberton, Ohio.

11. Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.

12. Westinghouse Elec. & Mfg. Co., Derry, Pa.

13. Locke Insulator Corp., Baltimore, Md.

Winter Convention Success Due Largely to Committee Efforts

THE INSTITUTE'S winter conventon held in New York, N. Y., January 25-29, 1932, brought forth an official registration of 1,429 persons. This attendance was highly gratifying and definitely refuted the occasional predictions that attendance would be small. Of even more importance perhaps is the fact that interest exhibited in the technical sessions and other features of the convention was in line with the attendance. All in all the convention may be said to have been very successful.

Opening of the Convention

The convention was officially opened at 2 p.m. January 25. Following introductory remarks by E. B. Meyer, chairman of the winter convention general committee, and W. H. Harrison, chairman of the technical program committee, the opening address was given by Dr. C. E. Skinner, president of the Institute. In his talk, presented elsewhere in this issue, Doctor Skinner outlined some of the activities and accomplishments of the Institute, and interestingly discussed the engineer as a citizen. At the conclusion of this speech, honorary membership in the Institute was conferred upon Dr. Frank J. Sprague, past-president of the Institute, and a pioneer in the development of electric traction. Doctor Skinner then stated that he had just received a letter from Sir Robert Hadfield, London, England, announcing a gift to the Institute of a bronze plaque commemorating the Faraday centennial. The meeting then was turned over to Mr. Harrison who formally opened the series of fourteen technical sessions. As abstracts of, or articles based upon, all 64 papers presented at these sessions already have been published (see ELECTRICAL ENGINEERING for January 1932, p. 39-49, and for February 1932, p. 130-2), they will not be reviewed here. However, summaries of the discussions following presentation of some of these papers will be given in subsequent issues of ELECTRICAL ENGINEERING.

One of the most impressive of the several interesting non-technical features of the convention was the joint medal presentation which took place on the evening of January 27. On this occasion the Edison Medal was presented to Dr. E. W. Rice, Jr., and the John Fritz Medal to Dr. M. I. Pupin. Many leaders in the engineering profession including several former Edison and John Fritz medalists were seated on the platform. These presentations, as well as the conferring of honorary membership upon Doctor Sprague, are reported elsewhere in this issue.

The success of the convention's annual buffet supper and smoker was repeated this year, on the evening of January 26, with an attendance of about 900. The committee responsible for this lively affair consisted of G. W. E. Draper, *chairman*, E. S. Banghart, W. G. Freeman, J. E. Goodale, R. A. McClenehan, L. K. Murphy, C. F. O'Neill, C. H. Sanderson, H. R. Searing, H. O. Siegmund, Morton Sultzer, and H. G. Wood. Following the buffet supper, an elaborate entertainment in the auditorium was provided by a capable master of ceremonies assisted by an excellent group of artists.

Annual Dinner-Dance

The annual dinner-dance was held in the Grand Ballroom of the Hotel Astor on January 28, and proved to be well attended. This event was preceded by a reception in honor of Doctor Skinner. The receiving line, in addition to Doctor Skinner, included the three honorary members present, Dr. Ambrose Swasey, Dr. Chas. S. Scott, and Dr. Frank J. Sprague; E. B. Meyer, general convention chairman, and H. P. Charlesworth, vice-president of the Institute for the New York District. Responsible for the success of this occasion was the dinner-dance committee composed of E. J. Johnson, *chairman*, C. R. Beardsley, N. M. Garland, W. S. Hill, H. L. Huber, R. H. Hughes, J. F. Kelly, F. A. Muschenheim, R. F. Penman, C. S. Purnell, H. R. Searing, and D. M. Simmons.

Entertainment for the women was arranged by the ladies' committee with Mrs. E. B. Meyer as chairman, assisted by Mrs. O. H. Caldwell, Mrs. H. P. Charlesworth, Mrs. H. C. Dean, Mrs. W. H. Harrison, Mrs. F. L. Hutchinson, Mrs. C. R. Jones, Mrs. G. L. Knight, Mrs. R. L. McLellan, Mrs. W. R. Smith, Mrs. C. E. Stephens, and Mrs. R. H. Tapscott. Activities included the popular and well attended luncheon and bridge, many independent theater parties organized through committee assistance, and excursion trips particularly suited to the interests of the women. In arranging trips for both men and women, some noteworthy successes were scored by the inspection trips committee composed of W. R. Smith, *chairman*, I. S. Coggeshall, G. F. Fowler, Henry Kurz, H. C. Otten, R. D. Parker, V. A. Shields, H. P. Sleeper, and R. L. Webb. The most popular trip was that to the U.S. Naval air station at Lakehurst, N. J., where the U.S.S. "Akron" was inspected. The registered attendance for this trip was 379 persons. The next most popular visit was that to the studio of the Jenkins Television Corporation, attended by 141 persons, while the Empire State Building drew the third largest number with 67. A scenic trip up the Hudson River also was available, and in addition to specified trips to local points of engineering interest, opportunity was afforded the members and guests to select from a comprehensive list of plants which might be of particular interest to them. The registration for all inspection trips totaled 893.

Too much credit for the success of the entire convention cannot be given to the general convention committee and to the convention executive committee. The first of these, with E. B. Meyer as chairman, included O. H. Caldwell, H. P. Charlesworth, H. C. Dean, W. H. Harrison, C. R. Jones, G. L. Knight, C. E. Stephens, and R. H. Tapscott; while the executive committee consisted of C. E. Stephens, *chairman*, C. R. Jones, *vice-chairman*, G. W. E. Draper, E. J. Johnson, Mrs. E. B. Meyer, and W. R. Smith.

The officially registered attendance at the convention was 1,429 persons; attendance at the sessions indicated that others were present. The following tabulation reveals the distribution of those who were registered:

District	Registrants
New York City and Foreign (3)	898
North Eastern (1)	233
Middle Eastern (2)	214
Great Lakes (5)	34
Canada (10)	23
Southern (4)	13
South West (7)	12
North Central (6)	1
North Western (9)	1
Total	1,429

President Skinner Urges Wider Engineering Effort

Dr. C. E. Skinner, president of the Institute, gave the address at the opening meeting of the 1932 winter convention, outlining some of the accomplishments of the Institute in the past, and pointing the way to future activities which might benefit electrical engineering as a profession and the nation as a whole. He also dwelt upon the responsibility of the engineer as a citizen, and urged greater activity in the affairs of the nation. Excerpts from Doctor Skinner's speech that relate to the more general aspects are given on p. 155 of this issue; those concerning Institute activities are quoted in the following paragraphs.

"The unusually fine program of papers before the 1932 winter convention is most satisfactory evidence that the American Institute of Electrical Engineers has been going forward during these years of depression. The winter convention, more than any other meeting of the Institute during the year, has come to be looked upon as the proper place and time to put into the record our outstanding accomplishments of the electrical industry for the year. The papers and discussions recorded at this and other meetings of the Institute constitute the history of the advances made in the electrical art in the United States, and to a considerable extent in the world. The application of electricity is without doubt the most important factor in the advance of our material civilization. It touches in some way almost every other factor which has a part in the advances which have been made during the last fifty years. Our Institute has a most enviable opportunity, supplying as it does the forum for the announcement of new discoveries, the record of achievements from year to year, and for discussion of the problems which the industry must face and find solution.

"During these last two years or more the Institute like governments, organizations, and individuals, has not been free from the effects of decreased income. This has but spurred us in an endeavor to give more service at less cost. It has been a challenge to greater efficiency in the conduct of our affairs. It has spurred us to provide, particularly in our publications, the best service to the members which can be given with the funds available. It has made necessary the limiting of the number and the length of papers presented, which is often a benefit rather than a detriment to their quality. It has spurred on the effort to carry the activities of the Institute more and more to the far flung Sections, and the eighteen or twenty Sections so far visited by your president have without exception indicated their enthusiasm and their unquestioned faith in the future of our great industry.

"This is no time to undertake expanded activities for the Institute, but it is not amiss to suggest new activities that may be planned now so as to be ready when funds will be available. It has seemed to your President that the time has arrived when an attempt should be made to write a comprehensive history of the Institute and of electrical engineering, particularly in regard to the formative years which were so fruitful of advances during the latter part of the last century. The curtain is going down for many of the players who took the chief parts in one of the greatest industrial dramas of history and much of the most interesting part of the story will be lost unless it can be written while some of these chief players are still with us. The writing of such a history would mean the collection of much data and a dramatizing and humanizing of the story as can be done by very few writers. It would seem that the American Institute of Electrical Engineers should be the body to arrange for the production of such a history if the funds could be made available and a qualified historian found.

"The Institute has been a pioneer in the standardization field, both national and international, and the recent reorganization of our standards work into the electrical standards committee should give great satisfaction to all our members interested in this subject. In the early years the standards committee of the Institute was undoubtedly the most logical and best possible means of carrying on this work, and in fact, the only place; but as the years went on, new organizations developed and new conditions arose which made it advisable to change our methods. The present plan recently adopted, largely formulated in its last stages by the late Dr. L. T. Robinson, promises to give us an entirely orderly and satisfactory procedure in the whole electrical standardization field, both national and international.

"The question of the licensing of engineers, bringing with it the necessity for a satisfactory definition of the term "engineer," and the establishment of standard qualifications by which we may be judged, has been brought about by licensing laws already passed in many States. It is of the utmost importance to all engineers that uniformity in these laws, definitions, and requirements, be established throughout the country.

"The members of the Institute, together with all other members of the engineering profession, may take some pride in the measures taken by our profession for the relief of the unemployed during this trying time of lowered industrial production. Through our local Sections, the cooperation of the groups being organized through the American Engineering Council, and through committees on unemployment, engineers as a group probably have done more for the relief of their fellow members than any other group or profession. Through our participation in the American Engineering Council we have joined in the organization of special committees in almost every State of the Union, and this action will do much to bring about greater solidarity in the engineering profession as a whole, even when this difficult time has passed. Our participation in the general work of the American Engineering Council and our joining with the plan of organizing state councils is bringing to us a greater appreciation of our responsibilities, not only as engineers but as citizens of the Republic. In times such as these, when every sort of scheme, sensible and fantastic, is before the national Congress, legislatures of the States, and even local governments, the calm considered judgment of the thinking citizen is required as never before. At this time there are before the Congress of the United States more than 12,000 bills calling for appropriations totaling approximately 30 billions of dollars, many of them with an engineering content. Another 12,000 bills are expected to be introduced before the session is over. As engineers and as citizens it is our duty as well as our privilege to take such part as we may through the American Engineering Council and its state councils, and by any other legitimate means, in giving advice as to which of these proposals are sound and which are unsound from the engineering point of view."

Frank J. Sprague Made Honorary Member

As previously announced, (ELECTRICAL ENGINEERING Feb. 1932, p. 139-40) Dr. Frank J. Sprague, pioneer in electric traction, was elected an Honorary Member of the Institute at the meeting of the board of directors held December 4, 1931. The formal installation of Doctor Sprague as

Honorary Member was made on January 25, 1932, at the opening meeting of the Institute's winter convention. Dr. C. E. Skinner, president of the Institute, in making the installation pointed out that such membership is accorded only by unanimous vote of the board of directors and only to men of extraordinary prominence in the profession. In addition to Doctor Sprague the Institute Honorary Members now are: Andre E. Blondel, John J. Carty, Herbert Hoover, Guglielmo Marconi, Michael I. Pupin, Charles F. Scott, Motoji Shibusawa, Ambrose Swasey, and Elihu Thomson.

In Doctor Sprague's brief speech of acceptance, he addressed the audience as the apostles of speech, light, transportation, etc., so necessary to contemporary civilization. Modestly he stated that he was probably the oldest person in the room, and perhaps this tribute to him was because of his age, although he preferred to consider it to be otherwise, and to be to himself and his individual accomplishments rather than to his age.

Edison Medal for 1931

Presented to Dr. Edwin Wilbur Rice, Jr.

FOR "his contributions to the development of electrical systems and apparatus, and his encouragement of scientific research in industry," the Edison Medal for 1931, highest award of the A.I.E.E., has been presented to Dr. Edwin W. Rice, Jr. The presentation was made at a special session of the winter convention of the Institute, Wednesday evening, January 27, 1932. Doctor Rice is a Fellow and past-president of the Institute; he is one of the pioneers in electrical development in the United States, and has played a conspicuous part in the building up of the General Electric Company, of which he is now honorary chairman of the board. After appropriate remarks by Dr. C. E. Skinner, president of the A.I.E.E., the aims and purposes of the award were outlined briefly by Dr. D. C. Jackson, past-president of the Institute and chairman of the Edison Medal committee.

"Our Edison medalists," said Doctor Jackson, "are procreators of brilliant dyes which have worked miracles in coloring the raw fabric of civilization with the complexion of conveniences and comforts beyond the reach of kings in previous generations. These men are creators, picked and culled. . . .

"Last year, as chairman of the Edison Medal committee, I gave some history of the Edison Medal and referred to the men who joined in its founding in honor of Mr. Edison. Since then the great one whose name the medal bears has passed from his human affairs, but we shall continue to cherish his name through the years as we add to the honor roll of medalists.

"It is not altogether easy to discriminate discerningly between achievements. . . . John Ruskin once said that 'hundreds of people can talk for one who can think; but thousands can think for one who can see.' Each year, of the thousands who can think, one is to be found for the Edison medalist who also can see—one whose works prove that he can see and has seen some part of the invisible in our realm of electricity, and has brought it into full play for the glory of the culture and for the comfort of the civilized world.

Dr. E. W. Rice, Jr.

Recipient of the 1931 Edison Medal for "his contributions to the development of electrical systems and apparatus, and his encouragement of scientific research in industry"

"Such men are stirred by scientific curiosity and a strong discontent, a discontent even with what seems good if it may perchance be turned into better. It is the author of great works resulting from this glorious kind of discontent that we single out and acclaim on these occasions of conferring the Edison Medal. We of the American Institute of Electrical Engineers are under debt to the far-sighted founders of the medal for the privilege of administering their trust."

Following these remarks, Doctor Jackson read an address prepared by Dr. Elihu Thomson who, because of ill health, was unable to be present to speak in person. Doctor Thomson for many years has been Doctor Rice's close friend and associate; he was the man chosen to receive the first Edison Medal (1909) and was awarded the John Fritz Medal in 1916; he is an honorary member and past-president of the A.I.E.E. Excerpts from Doctor Thomson's address are given in the paragraphs which follow.

Dr. Elihu Thomson Sketches Dr. Rice's Career

"It was while I was professor of chemistry and mechanics in the Boys' Central High School in Philadelphia, with Prof. Edwin J. Houston in charge of physics, that I first met Edwin Wilbur Rice as a pupil. . . . Rice entered the school in 1876 and graduated at the head of his class in 1880. What this meant in the training of a student may be illustrated thus: My class, known as the 55th, entered on examinations in 1866 about 170 strong, but of these only 18 graduated in 1870 at the completion of the four years' course. It was the same with the other classes, Rice graduating at the head of the 75th in like relation of numbers. Our relations began in the school work, in which I found him an earnest pupil, always wanting to learn, not only willing but eager to make all effort necessary for acquirement.

"When in 1880 I had decided to take up invention and electrical engineering work, Rice became a graduate, and . . . decided to associate himself with our new enterprise, practically as co-worker and assistant. With business associates, Houston and I had been carrying on work in Philadelphia. . . . On leaving Philadelphia for New Britain, Conn., where the American Electric Company had been organized to manufacture and exploit the Thomson-Houston system of arc lighting, Professor Houston's active connection with the enterprise ceased. This was in 1880, and to Rice and myself remained the task of nursing the new baby into vigorous life."

Doctor Thomson's address then outlined the difficulties experienced in the early history of this enterprise, during which time the Brush Electric Company of Cleveland, Ohio, acquired control of the American Electric Company, but later relinquished it to the "Lynn Syndicate." "I cannot say too much in praise of the invaluable assistance and perspicuous business acumen of Rice himself at

this juncture," Doctor Thomson continued," for it was he who met the Lynn representatives and showed them the valuable points of the invention embodied in the Thomson-Houston system of arc lighting."

Factory Superintendent at 22

Under the Lynn management a new and highly successful era began, and in November 1883 the manufacture was shifted to a new factory building in Lynn, Mass. Rice, then 22 years of age, was selected as plant superintendent at the new establishment.

"In his capacity of plant superintendent at Lynn (returning again to Doctor Thomson's address) an enormous amount of work fell to the lot of Rice, as the growth of the business extended into the a-c. field, incandescent lighting, and the electric railway; . . .

"It was during this period, and before the exodus which took many of our engineers from Lynn to Schenectady in 1892, as a consequence of the consolidation of the Edison General Electric with the Thomson-Houston interests under the presidency of C. A. Coffin, that our staff was enriched by the coming of the late Dr. Chas. P. Steinmetz to Lynn. . . . Rice had a leading part in securing the services of Steinmetz as a member of our technical and calculating staff at Lynn, leaving for Schenectady in 1892, or shortly thereafter. It was at this time that Rice was made technical director of the General Electric Company, a position held by him for many years, until promoted to the presidency, succeeding Mr. Coffin.

Founds Research Laboratory

"In his position as technical director of the company, his work extended not only through the departments at Schenectady, but covered the undertakings of the several other works. . . . The responsibility was great and increasing. It was during the period of his earlier years at Schenectady that the idea of a works research laboratory was entertained. I remember receiving a letter from Rice asking my opinion of the project and requesting a statement of some of the problems which it might take in hand. In reply I pointed out the vast field covered by our ignorance, the possible solution of problems by research, and endorsed the project warmly as likely to be a great element in future technical advance.

"Thus, under Doctor Rice, the great research laboratory at Schenectady was put into action, with Doctor Whitney at the head, and such co-workers as Dr. Irving Langmuir, Dr. W. D. Coolidge, and many others, contributing through the years to its output.

"There is no space to enter into any of the details of the researches in science and technology which have been the outcome. To see a complete revolution in the field of lighting alone, we have only to point to the modern incandescent lamp with its filament of tungsten wire made by the Coolidge process and to the studies of Doctor Langmuir on the gases present in the lamp bulb. . . . The part that Doctor Rice had in this can be estimated only by such knowledge as those close to the evolutionary scene were enabled to obtain . . .

Many Patents Received

"Naturally, one so busy with electrical engineering advances has received a large number of patents in the United States. These number about 115, taken out individually or jointly with others. None the less, Doctor Rice arranged the atmosphere, so to speak, in which others could do their best work, and introduced into the organization of the industry methods which not only have benefited the company itself, but have added materially to the welfare of the employees.

"Doctor Rice's long career of attainment and usefulness naturally has brought to him many recognitions in the form of medals, honorary degrees, and decorations, both here and abroad. Doctor Rice is, I think, richly entitled to the bestowal of the Edison Medal, an honor which had Edison himself lived to know of it, would have met with his warm approval. Edison on several occasions expressed his high regard for Doctor Rice's personality and versatile ability as inventor, manufacturer, business man and financier. I think I can say for the surviving recipients of Edison medals that we are glad to endorse the action of the Edison Medal committee of the Institute in making choice of Dr. Edwin Wilbur Rice for the award on this occasion."

Presentation of the medal to Doctor Rice by President Skinner followed, after which Doctor Rice responded.

Doctor Rice's Response Outlines Electrical History

"It is with profound pleasure," began Doctor Rice, "that I accept the Edison Medal, which I regard as the greatest of all prizes to be won by an electrical engineer. I shall treasure the medal itself as visible evidence that my work has met with the signal approval of my fellow engineers, and because of the precious memories recalled by the name and image which it carries.

"I am the first to receive this award since the death of the great man in whose honor it was established and whose name it bears; and I like to think that he would have regarded me as a worthy recipient. Among the most happy memories of my life are those of the days, all too few, which I was privileged to spend with Mr. Edison."

Doctor Rice then outlined the important developments in the field of electricity and electrical apparatus and equipment which he had observed throughout his career. These reminiscences began with his sight of a dazzling light (the arc light) at the Centennial Exposition in Philadelphia in 1876, which Doctor Rice stated was his earliest memory of anything electrical. He related seeing at the same exposition two Gramme machines, one being operated as a generator, and one as a motor. Speaking of the telephone Doctor Rice declared, "I shall never forget the thrill of my first message over the telephone. . . . I have never lost the sense of awe and wonder, that so simple a device is able to transmit and reproduce all the complex sounds, including human speech."

Doctor Rice also touched upon important inventions made by his contemporaries, including the invention of the incandescent electric lamp by Edison, Edison's experiments in the central station field, and his subsequent establishment of the first central generating station in New York. Later came the introduction of the single-phase a-c. system by William Stanley, and still later the multiphase a-c. system which at present is in almost universal use.

Early Electric Systems

Speaking of some of the earlier systems which marked the development of electrical power networks Doctor Rice remarked that "all these systems were commercially successful; they grew rapidly, but were highly individualistic, even antagonistic, and were limited to their respective fields." Parallel with developments in the electric power supply and central station fields, Doctor Rice mentioned Sprague's and Van Depoele's electric trolley systems, as being really the foundation for modern electric transportation systems.

What of the Future?

Departing from the past and present remarkable developments in the electrical art, Doctor Rice next had something to say about what might be expected of the future: "We of the engineering fraternity naturally think of the recent period as the electrical age," he said. "But these electrical and mechanical discoveries and inventions are not all. Similar progress has been made in chemistry, in biology, in astronomy, and in many other directions. . . .

"Why this sudden outburst of scientific achievement, so broad and general that our times may be aptly termed 'The Age of Applied Science?' The reason is clear: Men have found a way successfully to interrogate nature, to discover her secrets, to learn her laws, and then to put this

information to practical use. Scientific research is the common name for this new tool. . . .

"No one knows the correct answer to the question as to whether or not we have reached the end of our material progress; but in view of the short time that man has used this new intellectual tool, and, moreover, when one considers the immensity and complexity of nature, it is reasonable to believe that if the same methods continue to be employed, progress also will be continuous.

"Therefore no limit is in sight, provided, and this is an important proviso, that man himself does not call a halt. The forces of ignorance, tradition, and superstition are strong and view with some alarm the progress of science. There are many who say that these new methods have been too successful, especially as applied to the field of production, and point to our great surplus of material things, to the increase in 'technological unemployment,' and all the tragic circumstances of our present depression including the paradox of poverty in the midst of plenty.

"The engineer refuses to believe that the world's troubles can be laid at his door. He places most of the blame upon the waste and extravagances of war and misdirected economic effort, to the stimulation of high pressure sales methods, the over-pledging of future wages and income, and reckless speculation in inflated values.

Scientific Methods Must Be Continued

"While it may be admitted that there is no universal panacea and no *get well quick* cure, it would seem reasonable to expect real improvement if, for example, the same scientific methods which have been so effective in increasing production, could be brought to bear upon the problem of control and of balancing production against ultimate consumer demands. No claim is made that scientific men or engineers have a monopoly of wisdom or of brains; but it would seem that the methods which have proved so successful might be applied to the solution of the more complex social problems to the great advantage of all the people. Therefore instead of yielding to the forces of reaction, it is our duty to make strenuous effort to extend the use of the scientific method. This can be done only by education.

"Every man and woman should have the benefit of an education in the fundamental facts and methods of science. Every professional man should learn enough to understand something of the physical nature of the world, as well as of his own body. Science, in addition to creating all these new arts and new knowledge, may be accredited with something finer and more important. It has encouraged in the minds of its followers what may be called the scientific point of view.

"One who possesses this scientific point of view is inclined to be modest and tolerant of others; he searches for the truth; he hunts for facts which, if found, become his guide. He tries to see things as they exist, not as he has wished them to be; naturally he is honest with others but even more important, he is honest with himself in thought and in action. It is vitally important for our future welfare that our lawyers secure an education in science at least equal to their legal training. I single out the legal profession because the lawyer is today our political master. . . . If our legal doctors who make and interpret our laws remain ignorant of the new heaven and the new earth, what will happen to the poor bewildered common citizen.

"However, I think we may face the future with courage, as the expansion of educational facilities in recent years has been accompanied by an increase in the study of science in our schools and colleges. This may enable the new generation to meet the new problems with intelligence and success. After all, the forces of reaction and ignorance cannot prevail permanently in a country in which the voters are properly educated."

Dr. Michael I. Pupin Receives 1932 John Fritz Medal

FOLLOWING Edison Medal presentation Wednesday evening, January 27, 1932, the 1932 John Fritz Medal was presented to Dr. Michael Idvorsky Pupin, "scientist, engineer, author, inventor of the tuning of oscillating circuits and the loading of telephone circuits by inductance coils." Doctor Pupin is an honorary member and past-president of the A.I.E.E., and was the recipient of the Edison Medal in 1920.

The John Fritz Medal is an honor awarded by sixteen representatives of the four national engineering societies: American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers, and American Institute of Electrical Engineers. It was established in memory of John Fritz of Bethlehem, Pa., one of America's great pioneers in the iron and steel industries. The medal is of gold and is awarded not oftener than once a year for "notable scientific or industrial achievement, without restriction on account of nationality or sex."

This portion of the Wednesday night session was presided over by William S. Lee, junior past-president of the A.I.E.E. as chairman of the John Fritz Medal board of award. Mr. Lee introduced as the next speaker Bancroft Gherardi, past-president of the A.I.E.E. and vice-president and chief engineer of the American Telephone and Telegraph Company. Mr. Gherardi spoke at some length regarding the life and achievements of Doctor Pupin; his address follows.

Mr. Gherardi Outlines Doctor Pupin's Achievements

"Fifty-eight years ago, late in the winter of 1874, a young Serbian landed at Castle Garden. He was without money or property, without friends or influence, and without knowledge of the language of this country. Many would say that he had nothing; but this would fail to recognize the things which he had. He had good health, character, ambition, a mind eager to find knowledge and to use it, and high ideals. This evening I have been selected as the spokesman of four great engineering societies whose representatives are gathered here to pay a tribute of esteem and affection to him.

"Limitations of time compel silence upon Doctor Pupin's early struggle for an education, and his studies at Columbia University, at Cambridge (England) and at the University of Berlin; except only this: that no one can read the account which he gives of this period of his life in his wonderful autobiography without being convinced that in the earlier influence of his mother, and in the period in which he was getting his education, was laid the foundation upon which rest his many achievements during a long and varied career. From the time of his connection with the staff of Columbia University, the story of his life is a continuous record of contribution to our knowledge and our methods of thought. Of these only a few high spots can be mentioned this evening.

Invention of Loaded Telephone Line Well Timed

"Perhaps because I am a telephone engineer, I am starting by referring to his invention of the loaded telephone line. For several years prior to Doctor Pupin's work which led to his inventions and patents on this subject, it was known that the addition of continuously distributed inductance to a telephone circuit would add to the transmission efficiency of the circuit; that is to say, it would diminish

the losses of the telephone current during its passage through the wires. It had been suggested that similar results should follow from the placing of inductance coils at intervals in the circuit. This had even been tried experimentally without favorable results. By means of a beautiful mathematical investigation Doctor Pupin established the fact that it was not sufficient to place inductance at intervals in the circuit, but that the inductance must be designed with reference to the circuit conditions and must be uniformly spaced at intervals having a relationship to the shortest waves which it was desired to transmit. He confirmed the results of his mathematical investigations through a brilliant series of laboratory experiments and in addition he designed and demonstrated the advantages of the toroidal type of loading coil—a design which fundamentally has persisted even to the present time, although it dates from over thirty years ago.

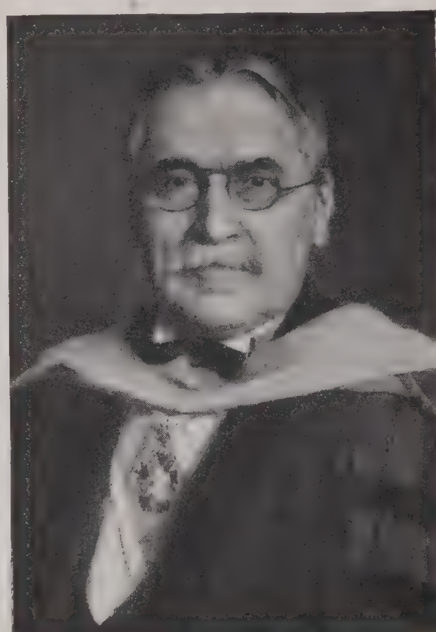
"Doctor Pupin's patents were acquired by the Bell Telephone System and from that day to this his inventions have played a fundamental part in long distance telephony. The time at which Doctor Pupin made these inventions was most opportune: They came just when telephone engineers were confronted with serious problems in the extension of long distance telephone service over greater and greater distances, and also when, due to the unfavorable effects of non-loaded telephone cables, very serious problems were arising in the planning of long distance lines. These problems were particularly difficult where the numbers of circuits required were so great that overhead open wire constructions presented formidable difficulties, and where the lines had to be brought into large cities.

"As part of the mathematical investigation of the loading problem, Doctor Pupin developed a mathematical theory of certain forms of artificial lines or electrical networks. Such artificial lines today have numerous important applications in the communication art.

Originated Tuned Circuit

"Doctor Pupin was the original discoverer of the electrically tuned circuit, that is, of the possibility of so proportioning the electrical characteristics of a circuit that it would respond energetically to any predetermined a-c. frequency. The electrically tuned circuit is used today in every important branch of the electrical art, in telephony, in telegraphy, in power transmission, and last but not least, in radio systems. It was first used by him and then by others in the analyzing of alternating currents, that is to say, in their separation into the different frequencies of which they were composed. In a way Doctor Pupin was unfortunate in the time in which he made this invention. At the time that he made the invention the radio art was practically non-existent and for many years thereafter it was used only for incidental and specialized purposes. Today, however, practically every home contains an electrically tuned circuit in the radio receiving set; but Doctor Pupin's discovery was so far ahead of the development of radio and therefore of the general use of tuned circuits that few realize that, if this contribution of his were to be removed from the radio systems of the present day, they would no longer function.

"Immediately upon the discovery of the X-ray, Doctor Pupin made two important contributions. He was the first to discover the phenomenon of secondary X-ray radiation; that is, that when X-rays strike on any matter, that matter becomes itself a source of X-ray radiation. This fact was not only important in itself, but it contributed to many other scientific advances in X-ray work. Doctor Pupin did much experimental work in X-ray photography and he was, I believe, the first in this country to make an X-ray picture with the aid of a fluorescent screen. The advantage of this method over those previously used was that it enormously shortened the time necessary for the photographic exposure and made it possible to take X-ray pictures in many medical and surgical cases where, without a short exposure it would not be practicable to get an effective X-ray picture.



Dr. M. I. Pupin

John Fritz Medalist for 1932 with the citation of "scientist, engineer, author, inventor of the tuning of oscillating circuits and the loading of telephone circuits by inductance coils"

"Doctor Pupin was the first to suggest the use of an electrical rectifier in connection with the receiving of radio signals. While his original invention made use of an electrolytic type of rectifier cell, his invention was broad enough to cover the use of any type of rectifier element. Here again Doctor Pupin was unfortunate in that his invention was so far ahead of the development of the radio art that it was many years after his work was done before there was any extensive opportunity to use this contribution practically.

An Educator as Well as a Scientist

"Doctor Pupin has had an important part in the building up of the scientific and engineering departments of one of our greatest educational institutions—Columbia University. He has not only contributed much in this way, but the graduates of Columbia who studied under him in many cases have made distinguished records in the fields of science and engineering. Of the many, I shall only mention two—Dr. Robert A. Millikan and Dr. Gano Dunn, a past-president of the A.I.E.E. These and many others testify with the greatest enthusiasm to what they owe to Doctor Pupin's teaching and to his inspiration.

"During the war, Doctor Pupin had an important part in starting the National Research Council. The purpose of this body as defined by President Wilson in his executive order with reference to it was: stimulating research in mathematical, physical, and biological sciences, and in the application of these sciences to engineering, agriculture, medicine, and other useful arts, with the object of increasing knowledge, of strengthening the national defense, and of contributing in other ways to the public welfare. Throughout the period of our participation in the war, Doctor Pupin devoted his abilities and his boundless energy to the vital problem of submarine detection.

"From Immigrant to Inventor"

"No statement of Doctor Pupin's achievements, however brief, could omit the mention of his autobiography, 'From Immigrant to Inventor.' It is in itself a contribution to literature, to science, and to education, and a wonderful study in the process of Americanization. From this book many native-born Americans can learn something of the spirit and aims of our country.

"Doctor Pupin's honorary degrees, his membership in societies and his presidencies of them, his American and foreign decorations, medals and awards, are too numerous to mention; but they testify to the judgment of others as to his personality and his work. In 1921 the A.I.E.E. awarded to him the Edison Medal, the highest honor which the Institute could confer. Now three other great engineering societies, civil, mechanical, and

mining, have joined with the electrical engineers in awarding to him their great joint honor.

"Doctor Pupin, I salute you: an inventor who has made important contributions to the application of electromagnetism to the uses of man; a scientist who has added important facts to our knowledge of science and contributed to scientific idealism; an educator who not only has an enviable record as to those who have studied under him, but who has advanced the cause of education; a citizen who has contributed much to this country; an American who is proud of the country of his adoption, and of whom his country is proud."

Following Mr. Gherardi's address, Mr. Lee presented the medal and certificate to Doctor Pupin with fitting remarks, to which Doctor Pupin responded as follows:

Doctor Pupin Responds

"As I sat here," began Doctor Pupin "listening to the kind eulogy, the generous eulogy of my good friend, Bancroft Gherardi, I could not help recalling to memory some of the faces of the peasants in my native village who were my schoolmates over 65 years ago. I saw them as if in a vision, sitting right here in the front row, looking around, dazed, wondering. One of them asked me, 'Michael, how in the world did you manage it? How many saints and angels, tell us, guided you on your way from the humble pasture lands of our little village to this glorious palace of American engineers?'

"To them I answer, 'Some day I will send you a translation of the beautiful speech of Bancroft Gherardi, which will answer the question better than I can.' . . . At every point of my uphill road, I met generous encouragement. Among these, I must mention the generous encouragement of my Alma Mater, Columbia College. Without its scholarships, fellowships and facilities for scientific research work, I should have been unable to contribute even the little I have contributed in the scientific field. In fact, I wouldn't be here this evening.

"Their generous spirit is the same as the generous spirit of the John Fritz Medal board which conferred upon me this very distinguished honor. I accept it; I accept it gladly. I am proud of it and I promise that I shall always consider it as a token of the generous spirit which I met at every step in this blessed land.

"Now, my friends, permit me to change my line of thought. I have been requested to address you and deliver to you, if possible, a message from the field in which I toil as an humble worker. That field is the field of power, of heat and electrical power."

[The remainder of Doctor Pupin's address may be found on p. 156-7 of this issue.]

Fourteen Institute Committees Hold Meetings During Winter Convention

DURING the 1932 winter convention in New York, N. Y., January 25-29, meetings were held by several of the Institute's general and technical committees. Proceedings of these meetings are summarized in the following paragraphs, except the standards committee meeting which is reported under the "Standards" department of this issue.

Student Branches

Previously, this committee had been authorized to get out a booklet telling what the electrical engineer is, what he does, what type of man makes the best engineer, what qualities he should have, and what education he should be given. This was prepared with the object of giving high school students some definite information concerning electrical engineering in order to discourage those who should not go into it, and to encourage those who should. Following the distribution of two copies of this booklet to each of a selected list of 1,500 of the leading high schools in the country, requests for 12,000 copies were received, 2,000 more than the original edition.

Because of the widespread and enthusiastic approval which this booklet met, the committee at its meeting voted unanimously to ask the board of directors to authorize the printing of an additional 20,000. (The board of directors later authorized the printing of 10,000 additional copies at present.)

The second of the two most important problems discussed at this meeting was that of arranging attractive programs for the student Branches, on the subject of safety. A bibliography to be prepared by the committee and a paper by Prof. C. F. Scott on this subject, are expected to be sent to all Branches. It was proposed that one type of meeting might consist of a paper by a student on "What Safety Means in Industry," accompanied by a demonstration of the prone pressure method of resuscitation from electric shock. It was voted that the committee arrange definite plans for conducting safety instruction through the student Branches.

Technical Program

Plans for the summer convention program were discussed by the technical program committee, and it was decided to include a session on protective devices in place of a session on application to iron and steel production, due to a conflict in date with the national convention of the Association of Iron and Steel Electrical Engineers. Also it was decided to add sessions on power generation, and on electrochemistry and electrometallurgy. The sessions which it is now planned to hold during the summer convention are: transmission and distribution, communication, automatic stations, electrical machinery, research, education, protective devices, power generation, electrochemistry and electrometallurgy, and selected subjects.

In connection with the number of pages available for printing, a discussion took place on the value of printing the technical committee reports submitted yearly by the various technical committees. It was decided that the question as to whether or not committee reports should be published, would be left to the discretion of the technical committee chairmen.

It was believed that section 89 of the by laws requiring that manuscripts of papers to be presented be received not less than ninety days before the date of presentation should be enforced, and therefore it was voted that "the manuscripts tentatively scheduled for the summer convention must be received at Institute headquarters, in complete form, by March 20, 1932, and where papers are not received those available on the docket will be substituted."

Automatic Stations

The automatic stations committee decided to request allotment to this committee of one session at the coming summer convention. Among the papers available are two on operating data and experiences with automatics, and two describing new devices.

It was decided to give further consideration to revisions of standard designations. A discussion was held concerning the various automatic schemes used with communicating circuits such as supervisory control and remote indication. A subcommittee was appointed to correlate these schemes with the various forms of communicating circuits available. In considering reclosing cycles on a-c. automatic reclosing circuit breakers, it was decided to investigate the present tendency to use only one or two reclosures instead of the usual three, and the use of practically instantaneous operation on the first reclosure.

Education

At the meeting of the committee on education, an attempt was made to determine the proper sphere of activity and responsibility of this committee. Without

much guiding precedent this was a rather complicated matter, but the following five lines of activity were adopted.

Post-college education is to be encouraged at all Sections where there may seem to be need for such work. It is contemplated that the plan of post-college education proposed by Prof. Edward Bennett in 1929, and which has met with such gratifying success in the Chicago Section, be used.

Educational work for unemployed engineers is to be promoted wherever possible, in line with the plan employed at Columbia University, Ohio State University, and Massachusetts Institute of Technology, where unemployed engineers may sit in lecture courses without charge and without credit. It also was decided to urge the board of directors to encourage the work of the committee on student branches in supplying to high school students reliable information regarding engineering. The committee endorsed the work being done by the Society for the Promotion of Engineering Education in connection with summer schools for engineering teachers. The session on education to be presented at the summer convention also was discussed.

Electrical Machinery

Three major items were considered at the meeting of the electrical machinery committee. A request from the standards committee, to proceed with the preparation of test codes on other apparatus similar to the transformer test code previously prepared by the transformer subcommittee, was considered. Because the purpose of this test code is to enable operators and others not familiar with electrical design to carry out tests on electrical machines, the subcommittees on synchronous, induction, and d-c. machines were asked to prepare test codes in their respective fields. These will supplement present standards.

Technical programs for the Providence meeting and the Cleveland convention were discussed, and plans were made for one session on electrical machinery at each.

The practise of surge voltage testing of transformers is now general, but because of the many difficulties in specifying test conditions and requirements to be fulfilled no standards have been prepared on this subject. It was the opinion of the committee that the formulation of such standards should now be attempted, and the transformer subcommittee therefore is planning to undertake this work in the immediate future.

Electrochemistry and Electrometallurgy

At the meeting of the committee on electrochemistry and electrometallurgy, papers for presentation at the summer convention were considered and suggestions offered both as to the papers to be presented and the material which might advisably be included in them.

The desirability was considered of securing the cooperation of the Institute in plans now in process of formation by the American Electrochemical Society for a Faraday centennial ceremony to be held during the World's Fair in Chicago in 1933. The organization of the membership along more effective lines also was considered, and it was decided to obtain the written comments of each member before submitting recommendations to the directors.

Electrophysics

Three matters were taken up at the meeting of the committee on electrophysics. First, there was a discussion of the general matter of the definition of electric and magnetic units, and of systems of units. The electrophysics committee has taken no formal action in this matter, of course, but has sent a communication to the standards committee. At the present time there is much active work under way on this subject on various organizations. Second, the general manner of reviewing of papers was discussed. Third, the committee discussed the general subject of the extent to which papers on electrophysics are being secured prompt and effective publication in the A.I.E.E. publications.

Instruments and Measurements

At the meeting of the committee on instruments and measurements, the activities of the subcommittees were reported and record made of the fact that the subcommittee on recording-instrument standards had completed its work. These standards were submitted to the standards committee for adoption. Similar action also had been taken in the case of the standard set of definitions dealing with telemetering.

A previously arranged joint meeting with the subcommittee on definitions for instruments and testing also was held. A considerable part of this meeting was concerned with a discussion of proposed changes in these definitions, and the authorization of a special subcommittee to act for the instruments and measurement committee so that the work on definitions of instruments and testing could be concluded as speedily as possible.

Power Generation

The committee on power generation received the reports of several subcommittees, and discussed plans under way for the preparation of papers for presentation at the coming summer convention. The recent notable progress in the use of high temperature and high pressure steam was reviewed and a paper now being prepared was discussed with special reference to modern methods of fabrication in which electricity played an important part. Power system interconnection was discussed, and it was pointed out that the main dearth of information now lies in papers describing the actual operating experience of large interconnected systems. Other papers also now are under preparation on the subjects of recent trends in power plant design and hydroelectric development. Further, a symposium is being prepared on the features of power station and system operation that contribute to the economy and reliability in the service rendered by several power systems.

Methods for securing continuity in the work of the committee were discussed, and for this purpose the drafting of an interim progress report for 1932, rather than the customary complete survey of current progress in power generation normally made at intervals of two years, was considered.

Power Transmission and Distribution

Reports from the various subcommittees were received first at the meeting of the power transmission and distribution committee. The present set-up of subcommittees was approved. The sessions to be held and papers to be presented at the next few meetings and conventions of the Institute were discussed, and papers for several of these definitely selected. For the summer convention the question was raised as to whether the session should be devoted to papers on lightning, or to papers on mechanical features of transmission systems, particularly conductor vibration. Since several sessions have been devoted to lightning during the past few years, while the mechanical features have been neglected, it was decided to devote the session to conductor vibration.

A general report on transmission and distribution in the United States is being prepared by members of this committee, for presentation at the International Electrical Congress in Paris, France, this summer, and it was brought out that this is to be a comprehensive report and should be of considerable reference value.

Transportation

A list of papers proposed for future technical sessions was discussed at some length during the meeting of the transportation committee. Following that, the chief discussion centered on the question of requirements for motive power. It was agreed that this is a most important subject, and one which had been touched upon very slightly in Institute meetings. It was suggested also that the subject be

broadened to include track maintenance as a function of axle loadings and other features, and to include design of motive power. A suggestion was made that the subject might be developed by means of a questionnaire, possibly in cooperation with the engineering division of the American Electric Railway Association.

TRANSMISSION TOWERS AND CONDUCTORS

An independent meeting of the subcommittee on steel transmission towers and conductors was held, taking the form of an annual gathering in which reports from different groups in the subcommittee were read. Some of the recent developments in theory and practise in connection with transmission towers and conductors were discussed, including the possibilities of covering these subjects in technical papers. Some of these subjects, although not actively followed by the subcommittee, have been checked from time to time to see that they get their due publicity, it being the aim of this subcommittee to foster as far as possible the writing and presentation of papers dealing with subjects that are of present day interest.

Among the subjects discussed were the development of hinged crossarms on steel towers, the investigation of embrittlement of hot-dipped galvanized steel, a new straight-line column formula, and a proposal for the drafting of requirements for modern steel tower lines as regards clearances and electrical characteristics The present status of studies of vibration of electrical conductors was reviewed.

LIGHTNING AND INSULATORS

At the meeting of the lightning and insulator subcommittee of the power transmission and distribution committee, the three preferred impulse test waves ($\frac{1}{2}\times5$, 1×10, and $1\frac{1}{2}\times40$ microsec.), previously adopted by the committee, were discussed and the following agreements reached.

1. These three waves are to be recommended for use in securing impulse data on insulators and insulation.

2. These waves could be secured without difficulty in any recognized laboratory today.

3. It was advisable for the laboratory making impulse tests to check the impulse wave obtained from the oscillograph with the calculated wave.

4. In all cases, impulse data given out to the engineering field should be accompanied by a record of the actual wave used in test.

It is believed that the above procedure will greatly clarify the present situation and enable those who use impulse data to obtain similar information from all manufacturers and compare and use it on an intelligent basis. The committee plans to put complete recommendations on preferred impulse test waves, general methods of tests, etc., in the form of a paper for presentation in the near future.

Past discrepancies in 60-cycle flashover of insulators were found to be due to different humidities at the time of tests. Correction for this feature brings flashover values within reasonable agreement.

The desirability of using the same impulse wave for insulation testing as for lightning arrester testing is recognized; but since the test conditions on arresters are inherently different from those on insulation, it was agreed that no logical basis for using the same impulse waves for both types of test exists.

It was agreed that the impulse characteristics of protective or coordinating gaps, should be obtained; and it was believed that this information would become available when similar information on bushings is obtained and made public.

The beneficial effects indicated by the use of the so-called counterpoise in reducing lightning troubles on transmission lines were discussed. The limited number of such installations is being closely followed, but further experience is necessary before final conclusions are made.

Great Lakes District Meeting

Arrangements essentially have been completed by the local committee for the three-day meeting of the A.I.E.E. Great Lakes District to be held at Milwaukee, Wis., March 14-16, 1932, with headquarters in The New Pfister Hotel. A tentative technical program and information about hotel rates were published in ELECTRICAL ENGINEERING, February 1932, p. 133. The few minor changes in the tentative technical program made since the first announcement are outlined in the following paragraph.

"Normal Frequency Arcover Values As Affected by Size and Humidity" by H. A. Frey and K. A. Hawley, Locke Insulator Corporation, has been added to the Wednesday morning session. The paper on "Factors Affecting Sparkover of Insulators and Bushings" by W. L. Lloyd, General Electric Company, formerly scheduled in the Tuesday morning session, has been transferred to the Wednesday morning session to bring together all of the papers on insulator sparkover. To make room for these and keep the number of papers per session nearly uniform, the two papers on mercury arc rectifiers were transferred to the Tuesday morning session.

A student session also will be held on Monday at 2 p.m. and selected papers will be presented by students of the Great Lakes District.

Research Assistantships Offered by U. of Illinois

To assist in the conduct of engineering research and to extend and strengthen the field of its graduate work in engineering, the University of Illinois maintains fourteen research graduate assistantships in its engineering experiment station. Two other such assistantships have been established under the patronage of the Illinois Gas Association. These assistantships, for each of which there is an annual stipend of $600 and freedom from all fees except the matriculation and diploma fees, are open to graduates of approved American and foreign universities and technical schools who are prepared to undertake graduate study in engineering, physics, or applied chemistry.

Appointments are made and must be accepted for two consecutive collegiate years of ten months each, at the expiration of which period, if all requirements have been met, the degree of Master of Science will be conferred. Half of the time of a research graduate assistant (approximately 900 clock hours for each ten-month period) is required in connection with the work of the department to which he is assigned.

Nominations to these positions, accompanied by assignments to special departments of the engineering experiment station, are made from applications received by the director of the station each year not later than the first day of April. Preference is given those applicants who have had some practical engineering experience following the completion of undergraduate work. Appointments are made in the spring, and become effective the first day of the following September. Research work and graduate study may be undertaken in architecture, architectural engineering, ceramic engineering, chemistry, civil engineering, electrical engineering, mechanical engineering, mining engineering, municipal and sanitary engineering, physics, railway engineering, and theoretical and applied mechanics. Additional information may be obtained by addressing The Director, Engineering Experiment Station, University of Illinois, Urbana, Illinois.

Illuminating Engineers Convention Announced.—The twenty-sixth annual convention of the Illuminating Engineering Society has been announced for the week of September 26, 1932, and is to be held at the New Ocean House, Swampscott, Mass. Officers of the society are; *president*, J. Daniels, Boston, Mass.; *vice-presidents*: J. W. Barker (F'30) New York, N. Y. and J. L. Stair, Chicago, Ill.; *general secretary*: E. H. Hobbie, New York, N. Y.; and *treasurer*, A. L. Powell, New York, N. Y.

F. L. Hutchinson
Succumbs to Heart Failure

AN UNTIMELY END came to a noble career when death stilled the courageous, fighting heart of F. L. Hutchinson, well beloved national secretary of the Institute, at 12:30 a.m., Feb. 26, 1932. Literally a martyr to the cause of his chosen life work, Mr. Hutchinson gave to Institute problems so generously of his indefatigable energies that he was unable to withstand the attack of heart trouble which finally took its fatal toll. The membership of the Institute has lost a leader militant in the defense of its best interests; the officers an able and willing team mate; the staff a kindly, keenly alert, inspiring taskmaster; and his family a devoted companion.

Early Experience

Frederick Lane Hutchinson was born in Elizabeth, N. J., April 2, 1866. He began his business experience in the service of the Pennsylvania Railroad Company in one of its principal offices in New York City, where he had several years' experience in accounts, correspondence, and general office work. In 1889 he entered Cornell University and was graduated from the electrical engineering course in 1893, when he entered the employ of the Westinghouse Electric and Manufacturing Company. After several years' experience in the manufacturing, testing, engineering, and sales departments in Newark, N. J., New York City, and Pittsburgh, Pa., he was transferred to the publication department, where for several years he was employed in preparing the technical literature of the Westinghouse company.

In 1901 he became manager of the publication department of the C. W. Hunt Company, New York, and in the following year became advertising manager of the National Electric Company of Milwaukee, Wis. A year later he was made manager of electrical sales for the same company.

A.I.E.E. Work

In 1904 Mr. Hutchinson returned to New York and undertook some special work on the Transactions of the American Institute of Electrical Engineers. Gradually the scope of his work was increased until, in February 1908, upon recommendation of Secretary Ralph W. Pope, he was appointed assistant secretary. Upon Secretary Pope's resignation after 27 years of service with the Institute, Mr. Hutchinson was, in August 1911, appointed acting secretary by the board of directors. On January 12, 1912, the board of directors of the Institute unanimously appointed him national secretary, upon the unanimous recommendation of the Institute's secretary committee.

FREDERICK LANE HUTCHINSON
1866 - 1932

Mr. Hutchinson became an Associate of the Institute in 1894 and was transferred to the grade of Member in 1913. He was thoroughly familiar with the history and policies of the Institute, the scope and duties of its numerous committees and representatives, and the relations of the Institute to other engineering and similar organizations, both in this country and abroad. He was one of the delegates of the Institute to the World Power Conference, London, 1924, and to the World Engineering Congress, Tokyo, 1929. He served as a member of various Institute committees, both before and after he became secretary. Immediately prior to his death he was a member of committees having supervision of several important activities, including publications, coordination of Institute activities, award of Edison Medal, and maintenance of Institute headquarters. Mr. Hutchinson also was a representative of the Institute on the Assembly of American Engineering Council, the division of engineering and industrial research of the National Research Council, and on the Engineering Societies Library Board. He was an enthusiastic worker for the development of the engineer and for the enhancement of the engineering profession, and was identified with various joint endeavors of the national engineering societies and allied organizations the efforts of which were directed toward that end.

Institute Grew Rapidly

His long experience as assistant secretary particularly qualified him for the duties of secretary. At the time of his appointment the Institute had little more than one-third of its present membership, and its rapid growth and increasing activities made growing demands upon the secretary's office, in meeting which Mr. Hutchinson displayed marked executive ability. He combined a very pleasing personality with a highly judicial temperament. With characteristic energy he mastered every phase of the Institute's activities, and the directors and governing committees of the Institute came to defer more and more to his judgment in all matters of Institute management. To every suggestion for the improvement of the Institute or changes in its policy he accorded a careful and impartial consideration, and the fairness of his decisions gained the respect and confidence of all with whom he dealt.

As the work of the Institute increased, Mr. Hutchinson gradually built up a small staff of assistants to whom he was the guide and inspiration. He inaugu-

rated a series of monthly office conferences at which reports of each of the departments were presented and discussed. These conferences were marked by the utmost frankness and cordiality, and Mr. Hutchinson's leadership encouraged the enthusiastic cooperation of his business associates.

In addition to his Institute membership Mr. Hutchinson was a member of the American Association for the Advancement of Science, the American Sociological Society, and the American Academy of Political and Social Science. Mr. Hutchinson also was a member of the Engineers' Club of New York, and of the Cornell University Club of New York.

Mr. Hutchinson's last illness really started prior to the recent winter convention. For two weeks he was down with a severe case of grippe from which he had not recovered when he returned to his office to take part in the rush of convention activities. Indomitable, he remained at his post until February 8, then to return to his sick-bed never to leave it alive.

F. L. Hutchinson as Seen by Some of Those with Whom He Has Worked

CHARLES F. SCOTT (A'92, F'25, HM'29, president 1902-3)—Since Mr. Hutchinson entered Secretary Pope's office as an assistant nearly 30 years ago the Institute membership has increased from 1,800 to 18,000 and its activities have increased in like ratio. In this development he has been a quiet, constructive force. As secretary for a score of years he has shown rare tact and skill in carrying out the policies and instructions of presidents and boards, while exercising his own good judgment and impressing his own ideas. While other officers have come and gone he has been a continuing, directive, creative factor in the development of the Institute. He was a wide reader and student of affairs, interested in economic trends and social evolution, with high ideals of the responsibilities of the engineer as citizen. I realize the loss to our electrical group, and to the engineering profession. But to me there comes a keen sense of personal loss in the passing of my long-time associate and sympathetic friend. His enlarging vision and progressive ideals engendered increasing appreciation and regard. How deep these were I did not fully realize until the shock of the telegram announcing his death.

M. I. PUPIN, (A'90, F'15, HM'28, president 1925-6)—I have just received the sad news of the death of our national secretary. It is shocking news; it will cast a deep shadow of sadness over our beloved Institute, just as it has cast it over me. His death is an irreparable loss to the Institute and to all its friends and his friends. I am one of them. While president of the Institute I met Mr. Hutchinson often and got to know him quite intimately. I always admired him and loved him, and when I got to know him more intimately I admired him and loved him even more. He was a loyal servant of the Institute and one of its most devoted members. His memory will live long in the hearts of our Institute membership and it will be the memory of the most distinguished servant of the Institute.

GANO DUNN (A'91, F'12, president 1911-12)—F. L. Hutchinson was a great Secretary. As assistant to his beloved predecessor, Ralph W. Pope, a fine loyalty long concealed his abilities. Upon Mr. Pope's elevation to the Honorary Secretaryship, during my presidency in 1911-12, the country was scoured for a "big man" appropriate to the Institute's growth and increasing importance, but a trial period of a few months quickly discovered that we already possessed him. We were in the position of the mariners dying of thirst off the mouth of the Amazon, who were signaled to cast their buckets overboard. Hutchinson was an organization statesman whom the title of National Secretary did not adequately describe. His capacity for self-effacing leadership under successive presidencies of one-year terms contributed in unmeasured degree to developing the usefulness of the American Institute of Electrical Engineers to her members and the public, and to establishing her high rank in the respect of her sister societies and the engineering profession throughout the world. Solving his problems by methods that were creative and constructive, rather than controversial or regulatory, he knew the value of goodwill and cooperation untainted by self-interest. His word was his bond and his personality radiated humor and trustworthiness. Our Institute has lost her focus and thousands of her members a dear friend.

FRANK B. JEWETT (A'03, F'12, president 1922-3)—In the death of F. L. Hutchinson, the electrical engineering profession in America has lost much more than the services of a highly efficient and effective secretary. To many members of the Institute the news of his death will bring pangs of poignant grief in the knowledge that they have lost a sincere, kindly, and always helpful friend. For nearly two decades the development and growth of the Institute to its present position as one of the great engineering societies of the world has been very largely influenced by Mr. Hutchinson. During his occupancy of the secretarial office, presidents, no two of them alike in their methods or purposes have come and gone in a continuing procession. To one and all Mr. Hutchinson proved to be a sound and discriminating counselor whose advice has insured the avoidance of many a pitfall. Probably none of us appreciate fully the extent to which this quiet, unobtrusive, but forceful man has been the guiding force which has directed the course of the Institute in new and uncharted waters or through the turbulent seas of potential discord which are always present when many men of many minds meet for discussion and action. Never seeking to take the center of the stage even when his greater familiarity with and understanding of some situation would have made this easily possible, he nevertheless always, in his quiet way, offered exactly the right suggestion at exactly the right time. Many a brilliant piece of work for which someone else was acclaimed the author was in the last analysis the embodiment of his mature conclusions.

W. S. LEE (A'04, F'13, president 1930-1)—It is with a sense of deep personal loss that I learn of the death of F. L. Hutchinson. My close association with him during my term as president of the Institute afforded me an opportunity of knowing him intimately and of observing and appreciating his zeal and enthusiasm for the work of our organization and his indefatigable industry in its behalf. Not only was Mr. Hutchinson zealous in the cause of his own organization, but he was always ready and effective in his cooperation with other engineering and business organizations, and with the public in general. His ability to bring about effective coordination between our own and other organizations was unusual, reflecting not only the real capacity of the man but an earnestness of purpose and a sincerity that commanded the respect and admiration of all who knew him. In his passing not only the Institute but the engineering profession generally and the public have sustained a severe loss.

C. E. SKINNER (A'99, F'12, president 1931-2)—I was shocked beyond measure to learn of the death of National Secretary F. L. Hutchinson. The Institute has suffered an irreparable loss in his passing. For many years, as administrations came and went, Mr. Hutchinson has been the real guiding spirit of the Institute. To him far more than any other individual the Institute owes its present position among the national associations of the United States. He handled all of its relations with outstanding wisdom and unfailing tact. He was universally respected and admired by all who knew him whether it be through official contact or through mere personal acquaintanceship. Presidents and boards of the Institute have depended upon him and have placed implicit confidence in his execution of the exacting duties of his office. His death comes as a great personal loss to me as it must to every member of the Institute who has ever made his acquaintance.

C. W. RICE (A'97, F'12, secretary A.S.M.E.)—Mr. Hutchinson's contribution to every situation was constructive, broad-gaged and progressive. With an intimate, almost daily, association since 1904 when he first took up the work of the Institute, I cannot remember a single instance where he took a position with respect to any subject that was not favorable to the accomplishment of the highest purpose of the project in hand. He was particularly able in clearing up a situation and had the invaluable habit of putting the matter under discussion in such shape that the group could act. In this process he gave his opinion with such courtesy that one could differ and the discussion be absolutely impersonal. Then, with absolute mental honesty and unselfishness, he would phrase the consensus of opinion even though not with his own approval. Every member of the Institute and every engineer with whom he ever came in contact will join in the tribute that Mr. Hutchinson directly contributed to the enhancement of the prestige of the profession and by so doing advanced the influence of the Institute.

Directors Meet During Winter Convention

The regular meeting of the board of directors of the American Institute of Electrical Engineers was held at Institute headquarters, New York, N. Y., January 27, 1932.

There were present: *President*—C. E. Skinner, East Pittsburgh, Pa. *Past-president*—W. S. Lee, Charlotte, N. C. *Vice-presidents*—H. V. Carpenter, Pullman, Wash.; H. P. Charlesworth, New York, N. Y.; L. B. Chubbuck, Hamilton, Ont.; W. B. Kouwenhoven, Baltimore, Md.; I. E. Moultrop, Boston, Mass.; and G. C. Shaad, Lawrence, Kans. *Directors*—A. E. Bettis, Kansas City, Mo.; L. W. Chubb, East Pittsburgh, Pa.; A. B. Cooper, Toronto, Ont.; A. E. Knowlton, New York, N. Y.; A. M. MacCutcheon, Cleveland, Ohio; F. W. Peek, Jr., Pittsfield, Mass.; C. E. Stephens, New York, N. Y. *National treasurer*—W. I. Slichter. *National secretary*—F. L. Hutchinson, New York, N. Y.

The minutes of the meeting of December 4, 1931, were approved.

Reports of meetings of the board of examiners held December 22, 1931, and January 20, 1932, were presented and approved. Upon the recommendation of the board of examiners, the following actions were taken on applications pending: 260 Students were enrolled; 413 applicants were elected to the grade of Associate; 13 applicants were elected to the grade of Member; 26 were transferred to the grade of Member and one was transferred to the grade of Fellow.

In accordance with a suggestion adopted at the conference of officers, delegates, and members held in June 1931, and upon the recommendation of the committee on coordination of institute activities, the board voted to take the following actions:

1. The appointment of a national standing committee on transfers, composed of five Fellows and Members and including at least one member of the board of examiners, to prepare literature which will encourage members of the Institute who are fully qualified for the higher grades to submit their applications, and to coordinate the activities of the Sections in connection with transfers.

2. The encouragement of the appointment by each Section of a suitable committee to study the qualifications of its members and to urge those who are fully qualified for higher grades to apply for transfer.

1933 Meeting Schedule Adopted

A schedule of meetings for the calendar year of 1933, prepared by the committee on coordination of Institute activities, and including all requests for meetings that had been received by the committee, was adopted, as follows: January, winter convention, New York, N. Y.; May, North Eastern District meeting, Schenectady, N. Y.; June 26-30, summer convention, Chicago, Ill.; Aug. or Sept., Pacific Coast convention, Salt Lake City, Utah; Oct. or Nov., South West District meeting, St. Louis, Mo.

The rules governing the award of national and district prizes were amended to provide for competition for both the national and district prizes for initial paper by graduate students who are members or enrolled Students of the Institute.

Sec. 34 of the by-laws was amended to read as follows (the amendment consists of the addition of the words "having three or more Branches"):

Sec. 34. To facilitate cooperation among the Student Branches, there shall be a committee on Student activities in each geographical district having three or more Branches, consisting of the vice-president, District secretary, and the counselors of all Branches within the District. The committee shall elect one of the counselors as its chairman, and may elect such other officers as it deems desirable.

Approval was given to the dates, October 10-13, of the Middle Eastern District meeting to be held in Baltimore in 1932.

The board approved amendments to the by-laws of the Lamme Medal committee, providing for a change from October 1 to November 1, each year, in the closing date for receipt at Institute headquarters of nominations for the medal.

Upon the recommendation of the standards committee, the following actions were taken:

Voted to relinquish the Institute's joint sponsorship of the sectional committee on wires and cables in favor of a single sponsorship under the electrical standards committee.

Approved the recommendation of the American Standards Association that the title of A.I.E.E. Pamphlet No. 100 be changed to "Recommended Practise in the Temperature Operation of Transformers."

Approved, as joint sponsor, a report of the sectional committee on radio on "Standard Vacuum Tube Base and Socket Dimensions" and "Manufacturing Standards Applying to Broadcast Receivers."

A report of a joint committee of engineering societies appointed to consider the question of the desirability of the organization of state engineering councils was presented, and upon the recommendation of this committee the board approved the general idea of encouraging the formation of state councils of professional engineers.

The president was authorized to appoint two representatives of the Institute on the council of the American Association for the Advancement of Science for the year 1932, and to appoint delegates to attend the annual meeting of the American Academy of Political and Social Science, Philadelphia, Pa., April 15-16, 1932.

Other matters were discussed, reference to which may be found in this and future issues of Electrical Engineering.

A.E.C. Urges More State Councils

At the annual meeting of the assembly of the American Engineering Council in Washington, D. C. January 14-16, 1932, the assembly voted to adopt the following recommendations made by a joint committee composed of representatives of the American Society of Civil Engineers, The American Society of Mechanical Engineers, American Institute of Electrical Engineers, and American Engineering Council, relative to the further formation of state engineering councils:

1. It is deemed essential for the advancement of the engineering profession that there be organized a state council of professional engineers in each state in which such a council does not already exist.

2. Each state council should be composed of representatives of the local sections of national engineering societies and the engineering and allied technical societies within the state.

3. The purpose of these councils should be to enable the engineering and allied technical organizations to render a more effective public service, and to contribute to the advancement of these professions. They may through appropriate channels communicate to the proper representatives of the state governments advice and suggestions relative to questions of legislation or administration and in the solution of which engineering and allied technical knowledge and experience may be involved or valuable, and may upon the request of local or regional organizations or in the absence of such organizations, render similar service in local affairs.

4. Membership in these councils should consist of any society or organization of the engineering or allied technical professions within the state whose chief object is the advancement of the knowledge and practise of engineering or of allied sciences, or the promotion of the interests of engineering or allied technical professions and which is not organized for commercial purposes. Membership in these councils should not be granted to individuals.

Providence Meeting Plans Progressing

In addition to the student sessions on Friday, May 6, 1932, the meeting of the Institute's North Eastern District, No. 1, to be held in Providence, R. I., May 4-7, 1932, will include four technical sessions. The symposium on "Traffic Control Systems" will attract considerable attention. Other sessions will be sponsored by the machinery, and transmission and distribution committees, and at the fourth session there will be presented several selected papers of general interest.

The dinner will be held Thursday evening, May 5. Also a wide range of inspection trips has been planned by the local committee. Headquarters will be at the Providence-Biltmore Hotel. Further details of this District meeting will be given in the April issue of Electrical Engineering.

Unemployment Relief Being Afforded by Institute and Other Engineering Groups

UPON the recommendation of the Institute's committee on the economic status of the engineer, the board of directors unanimously adopted a resolution at a meeting held in Kansas City, Mo., October 23, 1931, providing for unemployment relief. As reported on p. 975 of ELECTRICAL ENGINEERING for December 1931, this resolution recommended that each Section formulate and carry out a plan of relief embodying substantially the following features: That in each locality a committee of engineers be organized, composed preferably of representatives of all the engineering groups in the community and working in close cooperation with local sections of other societies and engineering groups, and so organized as to work in close cooperation with other local civic relief organizations. Further recommendations regarding organization were made, and it was suggested that these local committees conduct surveys of the need for relief and for local opportunities for constructive work or employment, using so far as possible the aid of engineers at present unemployed. Further, it would be the purpose of this committee to collect and administer funds for loans and remuneration to deserving unemployed engineers, and to perform such other duties as might be deemed advisable in each particular community.

SECTION ACTIVITIES SUMMARIZED

In response to this resolution, letters were written to each Section urging the consideration of organizing, in conjunction with other engineering groups, an engineers' unemployment relief committee. As the conditions in different communities vary widely, it is difficult to generalize upon the results which have been obtained. In some communities unemployment among professional engineers has been widespread, and much work has been done by the committee in alleviating this condition. In other sections, particularly those far from manufacturing centers, the situation has not been acute, and frequently the local civic unemployment relief organization has been considered adequate.

In those localities where relief work has been undertaken, the methods of attack vary widely. In certain communities the local situation has been such that the Section of the Institute has taken full responsibility for collection of funds and other relief work among the electrical engineers of the district. The San Francisco Section of the Institute has reached the conclusion that financial aid in the form of loans is the most effective means of relief for the conditions found in their particular district, and are concentrating on this form of activity. The Boston Society of Architects and the engineering societies of Boston, Mass., are cooperating in the collection of funds to be distributed as salaries to unemployed members of the profession who assist in emergency planning and research work to be used "in the advancement of city planning and regional data, in suggestions for rehabilitation of depreciated properties and districts, for the elimination of slums, for the long-range planning of the physical development of our various municipal departments, in economic surveys of various kinds, valuations or appraisals for various purposes, and in other similar projects."

More frequently, the Section cooperates actively with other relief bodies and places its special emphasis upon assisting the electrical engineer. Questionnaires have been sent out by many Sections and registration of those unemployed undertaken. Industries have been canvassed in an attempt to learn of positions available and the qualifications essential in filling these. A particularly valuable part of the work undertaken is a study of the fitness of the man for the position open and the economic necessity for aiding each individual. Considerable effort has been made to promote emergency work to be undertaken by the local and State governments; and toward the adoption of the scheme of spreading work as far as possible among the largest numbers of men, both in government and industrial activities. Among the Sections of the Institute which have been particularly active are, Atlanta, Boston, Chicago, Cincinnati, Cleveland, Connecticut, Dallas, Denver, Detroit-Ann Arbor, Ft. Wayne, Los Angeles, Milwaukee, Minnesota, Philadelphia, Portland, Rochester, San Francisco and Seattle.

Surveys have been conducted by practically all Sections of the Institute. Some of these indicate that there is very little unemployment among electrical engineers in the Section. Also, the surveys indicate that the largest part of the unemployed are young men, few of them with dependents, and most of them having homes to which they may return. Educational communities, especially, appear to be free from an acute unemployment situation, and in general it appears that throughout the country electrical engineers have not been so adversely affected as many other engineering and non-engineering groups.

NEW YORK CITY PLAN

Perhaps the most thorough and complete scheme for coping with the immediate unemployment problem is that developed in New York, N. Y., for the metropolitan district. A very definite method of procedure in collecting and distributing funds and otherwise providing unemployment relief has been set up and is functioning to aid a very large number of persons. As the details of this plan may be of assistance to other communities, space will be given here for its description.

Action was initiated by the American Society of Civil Engineers to form a committee to aid unemployment among engineers in this district. As a result of this action, the first meeting of the Professional Engineers Committee on Unemployment, known in New York as the P.E.C.U., was held October 21, 1931, with representatives from the four national societies of civil, mining, mechanical, and electrical engineers present. At this meeting it was decided that the engineering profession should carry on its own unemployment relief program. This decision was reached because the regularly constituted relief agencies in the New York City region held to an exceedingly rigorous standard of destitution, and further because part of the program was to prevent, so far as possible, members of the engineering profession from reaching this condition.

Later it developed also that it was exceedingly difficult to obtain information from those in need of relief. Engineers as a class have never been given to talking of their troubles. However, it was found that these men would speak more freely to another engineer than to a professional social worker.

A general committee of about 40 members consisting of engineers prominent in the profession, whose names were ample evidence of the high character of the undertaking, was immediately formed. This general committee, under the chairmanship of H. de B. Parsons, appointed an executive committee of six men with J. P. H. Perry, chairman, to carry on actively the work of soliciting funds and of unemployment relief. This committee directs some dozen standing committees, which are divided roughly into two groups: those subsidiary to a finance committee, chiefly concerned with the collecting of funds; and those working under a relief committee, providing direct relief in such forms as employment, loans, legal aid, and engineering education.

ENGINEERS CANVASSED TO OBTAIN BASIC DATA

The first step was to register the unemployed engineers in order to get an accurate estimate of the problem with which the committee was confronted. A postcard was first sent out to the metropolitan membership of the four societies advising them of the formation of the committee,

stating that its object was to devise methods by which engineers in need of assistance would be looked after by their brothers in the profession, and also advising members in a position to do so to be prepared to contribute to the movement.

A tentative organization was formed, headquarters established in the Engineering Societies Building, New York, and preparations made to register the engineers as soon as they came in. At a mass meeting held in the Engineering Auditorium on November 9, 1931, prominent speakers outlined the program to be carried out and also called for suggestions. The notice of the meeting carried this paragraph: "If you are unemployed and in need of assistance we urge you to register in person before November 10, at Room 201, 29 West 39th Street, New York City." Registration was very slow at first but increased rapidly from day to day as the movement gathered impetus.

Two policies were stated definitely at the beginning of the movement: (1) that the P.E.C.U. in affording relief would make no distinction between members and non-members of the four engineering societies; and (2) that all money collected for relief should be applied to relief purposes only, the necessary administrative funds to be obtained from other sources.

Subsequently, however, the demands placed upon the committee required a change in the policy regarding relief to unemployed engineers regardless of whether such engineers were members or non-members of the four societies. At a meeting of the executive committee on February 8, 1932, it was decided that with respect to placement of unemployed engineers on P.E.C.U. payrolls only members or former members of the four societies could be considered. However, in the case of placement of unemployed engineers on the payrolls of public organizations the present policy of assisting both members and non-members would be continued. Loans are to be made only to members or former members of the four societies. It was felt that these changes were justified by the fact that contributions have been made entirely by the membership of the four societies.

From the very first, the executive committee of the P.E.C.U. recognized that its problem from an administrative point of view was relatively more difficult than that confronting the great city committees the principal duty of which was to collect funds. Once funds were collected by such committees they were turned over to the organized charities of the city for distribution. The P.E.C.U., however, had not only to collect the money, but also to build up an organization composed wholly of engineers who were largely volunteer workers and also entirely inexperienced in social welfare work. The problem was one of organizing to spend the money with justice but leaving no loophole for scandal. Great care has been exercised in safeguarding the expenditure of this money, not only in making just loans, but in handling payrolls carefully.

"Made Work" Bureau Established

One of the first steps was to make contact with the regularly established relief organization, which is the New York branch of the President's Organization on Unemployment Relief, and which had already established a "made work" bureau. The officials of the latter organization because of the obvious advantages of such aid accepted the offer of having this "made work" carried out with proper engineering supervision; however, because the destitution requirements of these regularly appointed agencies were such that many engineer applicants in need of help were unable to qualify, the P.E.C.U. established its own "made work" bureau.

Organization of Engineers Developed

The organization of the P.E.C.U. was developed by a gradual process to its present stage. In addition to the general and executive committees already mentioned, is a committee on clearance, its chief duty being to maintain contacts with existing relief agencies; a committee on organization to take care of problems of internal administration and to act as a comptroller of the administration funds; and a publicity committee. The remainder of the work is divided into two groups, financial and relief.

The work of the finance committee is concerned with the raising of funds for relief purposes only. So far, this has been done by appeals to the metropolitan district members of the four engineering societies, principally by letter. A special list of engineers believed to be able to make sizeable contributions has been approached by direct solicitation. Money collected by the finance committee is deposited with United Engineering Trustees, Inc., which acts as the treasurer of the P.E.C.U. There are many obvious advantages inherent in the use of an established concern for this purpose. The money is then turned over to the organization paymaster and timekeeper for distribution.

Activity of Relief Committee

The relief committee supplies direct and indirect relief in all forms, together with the developing and prosecution of plans for "made work." The working of this committee perhaps may be presented most easily by considering the procedure of an engineer presenting himself for

Table I—Dollar Value Obtained by Feb. 15, 1932

Cash collected	$ 68,928.98
Unpaid pledges	14,488.63
Contributed for administration	5,318.91
State and federal contributions to carry on work of the U.S. Geological Survey	24,000.00
Relief obtained by P.E.C.U. men through others (wages, etc.)	99,025.00
Certain relief funds for use in portions of United States not covered by P.E.C.U.	5,683.35
Total	$217,444.87

assistance. He first goes to the committee on registration where he fills out duplicate cards, one of which goes to the registrar who determines his engineering status and decides whether or not it entitles him to relief from the committee; the other card is filed with the committee on research and vital statistics. Cross-reference of these latter cards is made to show the applicant's so-called "degree of destitution" as follows:

1. If in need of immediate aid
2. If his resources will last one month
3. If his resources will last for longer periods

The engineer is next interviewed by the department of employment which endeavors to place him immediately in some gainful occupation, always giving preference to those in immediate need. If a member of one of the four societies, he is also automatically registered with the Engineering Societies Employment Service for a permanent position.

If the interview with the registration committee indicates that the engineer requires immediate financial help or legal advice, he is sent to the department of certification of loans and payroll where, if deemed advisable, he is given a requisition on the treasurer for a loan, in return for which he gives his note which is non-interest bearing and payable on demand. Clothing, if necessary, is made available by the social service committee sponsored by the Engineering Woman's Club. Sound advice or legal assistance is made available without expense by the legal counsel.

Arrangements have been made with Columbia University whereby unemployed professional engineers are admitted to lecture courses on engineering and allied subjects without fee and without academic credit. In this way they not only may improve their general mental attitude, but may place themselves in a position to increase their earning capacity at the end of the economic depression.

There is a committee on plans, the function of which is to survey and chart the possibilities for "made work," having an allied committee charged with the responsibility of putting these plans into effect. A committee on opportunities in

business and industry was started the first of the year to make contact with various business and industrial organizations, bringing to their attention the possibilities of having their plant surveyed by unemployed engineers so as to improve plant layout and processes of manufacture, and increase efficiency.

Work Accomplished

Direct contact is maintained between the P.E.C.U. and the Engineering Societies Employment Service to provide permanent positions, when available, for the registrants. These two bodies, however, are entirely separate, the P.E.C.U. being instituted to provide prompt relief for engineers in immediate need and register all engineers out of work. It is financed entirely by voluntary gifts.

On February 15, 1932, the total registration had reached 1,806, somewhat less than half of which consisted of members of the four engineering societies. Of those registered on that date, immediate help had been found to be needed by 450. A total of 846 already had been placed in positions. Contact is maintained with registrants and the records revised from time to time. As shown by Table I the total dollar benefit obtained by the P.E.C.U. for the engineering profession was $217,444.87.

In addition to the direct financial benefit, there are of course many other advantages being derived from this plan, and it is intended to support actively the various forms of unemployment relief so long as the emergency exists. Plans are now being made for a more direct canvass of professional engineers who are in a position to contribute. The registration continues to increase each week, and as many of these are cases of destitution, the committee is spurred to greater activity.

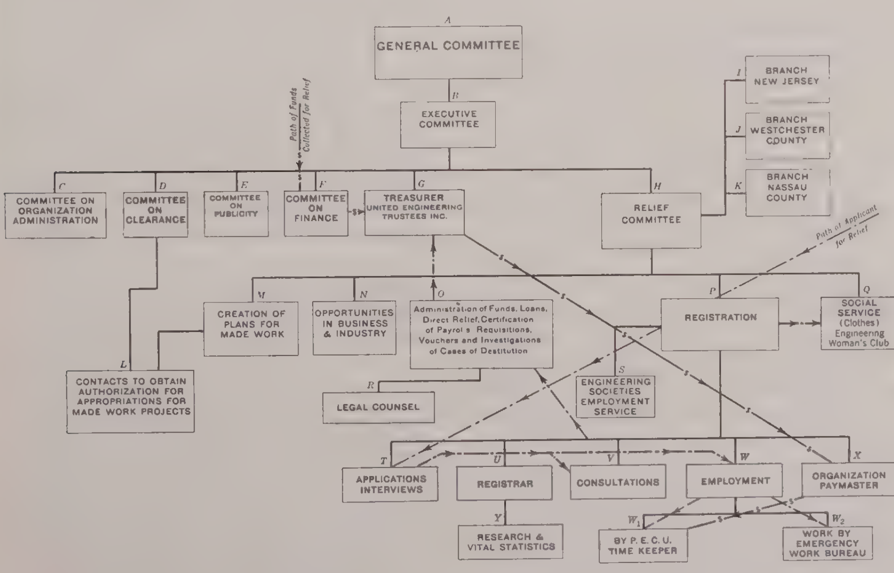
Engineers National Relief Fund

Based upon a contribution of $5,000 received from President Hoover, a fund for national use is being built up, administered by a separate committee composed of E. C. Hutchinson, *chairman*, W. G. Atwood, Langdon Strobel, and E. B. Meyer, representing, respectively, the mechanical, civil, mining and electrical engineering societies, and with Ernest Hartford, assistant secretary of the American Society of Mechanical Engineers, acting as secretary of the committee. The policy has been adopted for the use of this fund as a loan primarily for members of the four national societies, or to members of local societies with which the local sections of the four societies are affiliated. The loans will be the basis of a revolving fund, and will be made only for brief period consistent with providing an emergency service.

Because of the limited size of this fund, it is felt that so far as possible the engineers of the larger communities where sections of the societies are organized should care for their own engineering dependents, so that more latitude will be provided for aiding the very considerable number of engineers living in isolated parts of the country where there is no organized group to take interest in them.

American Engineering Council Plan

The American Engineering Council also is active in unemployment relief, working through state councils and local committees. While assisting in relieving the immediate unemployment situation, the more important phases of the work being carried on by this body probably are those concerned with the permanent stabilization of employment and industry, and in urging local, state, and national governments to adopt measures which may relieve the present situation and be effective in preventing recurrences of the present cycle. A recent report of this body includes the prediction that a marked social advance will result from the present widespread relief activity; better relations between employers and employees are being built up, a sober view of public financing is being taken, and corporate management is being shaped along sounder lines. It is asserted that these and other constructive developments arising from the depression will make for a more stable economic organization.



Organization chart of the New York City Professional Engineer's Committee on Unemployment

Sectional Committee on Noise Recommended

The organization of a sectional committee on noise measurement under the procedure of the American Standards Association was recommended by a general conference of 32 representatives of 18 national bodies held in New York, N. Y. on January 29, 1932. It also was recommended that this committee function under the technical leadership of the Acoustical Society of America. The scope of the project as recommended by a steering committee, consisting of Prof. F. O. Knudsen, E. E. Free, P. L. Alger (F'30), H. R. Summerhayes (M'16), R. G. McCurdy (M'28) and Dr. Harvey Fletcher (F'30), is the preparation of general standards of nomenclature, units, scales, and measurement in the field of acoustics, with special reference to noise measurements.

It was the feeling of the Institute's committee on sound under the chairmanship of P. L. Alger that the widespread interest in noise and the rapid development now going on in noise measuring instruments make desirable national standards in this field. Already there are eight or more national noise committees, most of which have definitely set before themselves the task of preparing standards of noise measurements. Hopeless confusion must result unless these various projects are coordinated by some such means as this recently organized sectional committee under the A.S.A. Therefore the A.I.E.E. committee on sound cordially endorses the formation of this sectional committee and expresses its desire to carry out its work on noise standards through this organization. It is the further feeling of the Institute's committee that the scope of the sectional committee should be as stated by that

body, namely, the preparation of general standards of noise measurements, and that test procedure and standardized methods of defining the noise characteristics of particular apparatus in particular locations should be left to the individual member organizations for later development.

The concentration of the sectional committee's work for the present chiefly on the standardization of nomenclature, units, and scales should become the basis for further progress in the science of noise measurement. The complex nature of noises and their effects upon the ear introduce confusion in the measurement of noise, and none of the noise meters yet designed can translate the approximate physiological and psychological effects of noise into definite units of measurement. Definition and standardization of these factors alone will do much to make possible real progress in the engineering application of our knowledge to the reduction in noise of apparatus.

Letters to the Editor

The Reactive Voltampere Conventions

To the Editor:

When we say that the "power factor" is leading we mean by tacit agreement that the current leads the voltage. Further, when we plot these as vectors, we are required to use a counterclockwise rotation to agree with mathematical custom.

Now if leading reactive voltamperes are called negative, there is a reversion in appearance to the old clockwise diagrams, leading voltamperes appearing to lag behind the power unless a clockwise sense is assumed. If power and reactive voltamperes are considered as true double-frequency vectors then we are forced to define leading reactive voltamperes as positive in order to maintain the counterclockwise convention. In this I am assuming that the polarities of mathematics must be accepted in all Cartesian charts.

To argue that lagging reactive voltamperes should be positive because $R + jX$ represents an inductive impedance is useless, for the inverted argument that it should be called negative because $G - jB$ represents an inductive admittance is just as good and more to the point in constant voltage systems.

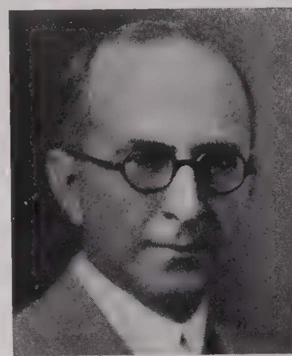
Be consistent, call leading reactive voltamperes positive and maintain the appearance of counterclockwise rotation.

Very truly yours,

V. G. SMITH (A'26)
(Assistant Professor of Electrical Engineering, University of Toronto, Toronto, Canada)

[**Editor's Note:** This letter discusses one division of the "Proposed Definitions of Power System Terms" (see ELECTRICAL ENGINEERING for February 1932, p. 106-7) developed by a special subject committee of the A.I.E.E. committee on power transmission and distribution. Further discussion is invited on any of the proposed definitions.]

Utility Executive Advanced



F. B. LEWIS

F. B. Lewis, formerly vice-president and assistant general manager of the Southern California Edison Company, Ltd., Los Angeles, has been promoted to the position of vice-president and general manager. Mr. Lewis graduated from Rose Polytechnic Institute at Terre Haute, Ind., 26 years ago, and has been with the Edison Company continuously since that time. Among his early accomplishments was the installation of the first 33-kv. transmission line by the Edison company to bring power from Santa Ana River Canyon to Los Angeles, Calif.

Engineering Foundation

Election of United Engineering Trustees Held

Officers elected to serve United Engineering Trustees, Inc. for the year 1932 have been announced. H. A. Kidder (F'29) was elected president, and H. V. Coes and Col. A. S. Dwight were named vice-presidents. Dr. A. D. Flinn, director of the Engineering Foundation, will serve as secretary, and C. P. Hunt as treasurer. Other members of the board of trustees were chosen as follows: F. E. Winsor, Boston, Mass.; C. A. Mead, Newark, N. J.; A. S. Tuttle, New York, N. Y.; G. D. Barron, Rye, N. Y.; R. M. Roosevelt, New York, N. Y.; E. R. Fish, Hartford, Conn.; F. A. Schaff, New York, N. Y.; H. P. Charlesworth (F'28), New York, N. Y.; and A. W. Berresford (F'14) New York, N. Y.

The United Engineering Trustees was established in 1904 as the United Engineering Society "to advance the engineering arts and sciences in all their branches, to further research in science and engineering, to maintain a free public engineering library, and to advance in any other manner the profession of engineering and the good of mankind." As the joint agency of the four national societies representing the civil, mining, mechanical, and electrical engineers, it owns and administers the Engineering Societies Building at 33 West 39th Street, certain endowment and other funds, and other properties committed to it. Through the Engineering Foundation, the library board, and the administrative department, it aids research in engineering and the sciences, operates the Engineering Societies Library, and carries on other activities.

Standards

Standards Committee Meets During Winter Convention

At the meeting of the standards committee of January 26, 1932, a number of subjects was discussed. Attention was called to a difference between A.I.E.E. standard No. 20, "Air Circuit Breakers," and the standard of the National Electrical Manufacturers Association for the same apparatus. The A.I.E.E. rule permits a 30-deg. cent. rise on contacts whereas N.E.M.A. permits only 20 deg. After receiving the report of the A.I.E.E. subcommittee which developed "Air Circuit Breakers" the standards committee approved a change in the A.I.E.E. Standard to 20 deg. unless objection is registered by the principal users of air circuit breakers.

At this same meeting, the recommendation of the standards council of the A.S.A. that the sponsorship for the sectional committee on wires and cables, now vested in nine associations including the A.I.E.E., be transferred to the sole sponsorship of the electrical standards committee was recommended to the board of directors for approval. This newly-organized electrical standards committee (as described on p. 845 of ELECTRICAL ENGINEERING for Oct. 1931) is the joint body representing eleven organizations and working under the A.S.A.

A suggestion of the scopes committee

of the electrical standards committee that the title of A.I.E.E. pamphlet No. 100 "Recommendations for the Operation of Transformers" be changed to "Recommended Practise in the Temperature Operation of Transformers" was presented to the standards committee and approved. No. 100 now will go to letter ballot of the standards council of the A.S.A. for approval as American recommended practise. Also, in accordance with a suggestion of F. D. Newbury (F'21) the standards committee on January 26 recommended an extension of scope of the sectional committee on transformers to cover all transformers and other equipment contained in A.I.E.E. standards No. 12 "Constant-Current Transformers," No. 13 "Transformers, Induction Regulators and Reactors," No. 14 "Instrument Transformers" and also pamphlet No. 100 "Recommendations for the Operation of Transformers."

The committee recommended to the board of directors the approval by the Institute as a joint sponsor of the reports of the sectional committee on radio dealing with "Standard Vacuum Tube Base and Socket Dimensions" and "Manufacturing Standards Applying to Broadcast Receivers."

A report made up of definitions relating to telemetering has been received from the instruments and measurements committee. As the sectional committee on electrical definitions has a subcommittee under Dr. J. F. Meyer (M'13) dealing with instruments and testing, the report of the technical committee was referred to that group for consideration and inclusion in their report.

Form and Arrangement of Published Standards

The report of the special committee on form and arrangement of published standards was made under date of November 30, 1931 and now is available in pamphlet form. This report is the work of a special committee of the American Standards Association, appointed in January 1925. The committee's objective has been the preparation of publication practises to be recommended by the A.S.A. for use by all bodies developing standards particularly under A.S.A. procedure.

The committee selected a page size of 7¾x10⅝ in. but also recognized three other suitable sizes. Alternative procedures are included in a number of other instances. It is hoped that experience in using the recommended practises will permit eventual elimination of the alternatives. Copies of the report may be obtained from A.S.A. headquarters, 29 West 39th Street, New York, N. Y.

Personal

J. C. Parker (A'04, F'12) who has been chosen to succeed M. S. Sloan to the presidency of the Brooklyn Edison Company, Brooklyn, N.Y., has been its vice-president in charge of engineering since 1926. Besides being possessed of a wide experience in the many practical fields of application of the profession he has had considerable experience also in the academic field. For some time he was an instructor in mechanical and electrical engineering at Union College, Schenectady, N. Y., under Dr. C. P. Steinmetz, giving in addition a course in thermodynamics and another in the mathematics department. His B.S. in M.E. was conferred upon him by the University of Michigan from which he was graduated

J. C. PARKER

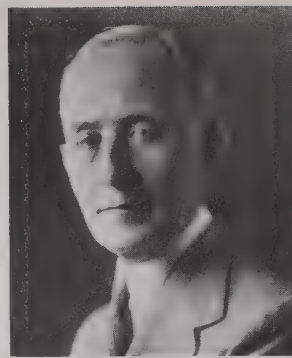
in 1901, this same institution the next year conferring upon him his A.M. degree for advanced work in mathematics, physics, and structural engineering. In 1904, his E.E. degree was won also from the University of Michigan by work done *in absentia*. Returning to the industrial field in 1904 Mr. Parker became assistant to the engineer in charge of construction and design for the Ontario Power Company's plant at Niagara Falls, the largest hydroelectric undertaking of its time. Upon completion of the first section of the Ontario Power Company's plant in 1905, he went to Buffalo as assistant to the vice-president and chief engineer of the construction company building the lines of the Niagara, Lockport, and Ontario Power Company from Niagara Falls to Syracuse. This was the first 60,000-volt transmission line, and the engineering for it was done by R. D. Mershon (A'95, F'12) past-president of the Institute. In this same year Mr. Parker became mechanical and electrical engineer of the Rochester Railway & Light Company, in charge of the engineering department; to this engineering work shortly was added the organizing of the power sales engineering division and economic investigation of power and illuminating conditions in company works. In 1915 the University of Michigan recalled him as professor of electrical engineering in charge of its department of electrical engineering, and this was the position from which he resigned in 1922 to become electrical engineer of the Brooklyn Edison Company. While primarily interested in higher mathematics and physics, Mr. Parker later became deeply concerned with the practical aspects of standardization and the simplification of production, design and construction. He was chairman of the Institute's delegation to the American Standards Association, and December 9, 1931, at the annual meeting of the American Standards Association was elected to serve (1932) as vice-chairman of the Standards Council. He has served the Institute in several capacities including that of vice-president (1921-2). He is a member of the American Society of Civil Engineers, the American Society of Mechanical Engineers, and of the Engineers' Club of New York.

Giuseppe Faccioli (A'04, F'12) who retired from active professional service May 27, 1930, when he withdrew from the office of works engineer and associate manager of the Pittsfield works of the

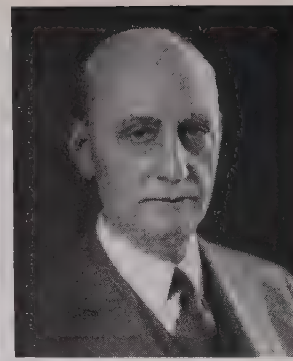
GIUSEPPE FACCIOLI

General Electric Company, has been chosen as the A.I.E.E. Lamme medalist for 1931. Mr. Faccioli, a native of Italy, graduated with high honors in both mechanical and electrical engineering from the Institute of Technology at Milan. He came to this country at the age of 25 and spent the first year of his career upon the design of a-c. machinery. He attracted the attention of the late William Stanley, inventor of the transformer, and through this association and that with other pioneer engineers, Mr. Faccioli has accomplished professional work which forever will be outstanding in the electrical engineering world. High tribute has already been paid him by men prominent in the profession; he has been hailed

as "a mathematical genius and a veritable wizard" in his chosen calling, but as "none the less human" in consequence of this personal achievement. Especially have the younger engineers gained from him knowledge and inspiration. His work with the General Electric Company covered a span of 25 years, and upon his retirement he was presented with a testimonial, brilliantly hand illuminated and signed by more than 150 names of the men who had worked with and for him during that period of his own service to the company and to the profession. This presentation was made in Schenectady, N. Y., by the late Doctor L. T. Robinson, (A'04, F'12), then in charge of the company's general engineering laboratory, with S. H. Blake (A'03, F'17), general engineer of the General Electric Company, and J. L. R. Hayden, the other member of the company's general standardizing committee. Always keenly interested in the A.I.E.E., Mr. Faccioli has been an untiring worker in its behalf, serving on many of its committees and as manager and vice-president. In 1928 he was decorated by Mussolini with the emblem of the Commandant of the Crown of Italy. Mr. Faccioli in relinquishing active duties with the General Electric Company becomes a consulting engineer, retaining his keen interest in all affairs of the organization.



PHILIP TORCHIO



F. W. SMITH

W. D. COOLIDGE

Philip Torchio (A'95, F'12) vice-president of the New York Edison Company, New York, and past-president of the New York Electrical Society, has been elected by his board of directors to serve as senior vice-president of the New York Edison Company. Mr. Torchio was born in Como, Italy, in 1868 and came to New York in 1893. He became a naturalized citizen and since 1895 has been with the New York Edison Company interests. He served for many years as a consulting engineer for affiliations of the Consolidated Gas Company and the New York Edison: namely, United Electric Light and Power Company, New York and Queens Electric Light and Power Company, Yonkers Electric Light and Power Company, the Westchester Lighting Company, and the Bronx Gas and Electric Company. He pioneered in the introduction of the 132,000-volt underground cable in this country and is the author of considerable technical literature on the economics of electric light and power generation and distribution. He is a member of Franklin Institute, has served the Institute as chairman on committees on power transmission and distribution, power stations, and economics of electric service, and as a member of the standards committee, the United States National committee of the International Electrotechnical Commission, electrical machinery committee, meetings and papers, power test code, and protective devices committees. In the Association of Edison Illuminating Companies, he has acted as chairman of the committee on high potential disturbances, symposium on system troubles, committee of conferees on armature coil temperatures of large generators and the committee on high tension cables. Also he has been a member of the committee on power generation and the committee on standards, and a representative on sectional committee on ratings of the American Engineering Standards Committee, now the American Standards Association. He was chairman of the National Electric Light Association's committee on underground construction and of the joint conference committee on standards. Mr. Torchio was a member of the American committee on electrolysis, the American Commission to the World Power Conference, American Engineering Standards committee sectional committee on rating of electrical machinery and the sectional committee on insulated wires and cables.

F. W. Smith (A'05, M'12) who has been serving the United Light and Power Company of New York as its vice-president and general manager, has been chosen to succeed M. S. Sloan as president of the New York Edison Company and the United Electric Light and Power Company. Already Mr. Smith is chairman of the board of directors of the New York and Queens Electric Light and Power Company and president of the Brush Electric Illuminating Company of New York. The year 1930 rounded out an uninterrupted 52-year service with the United Electric Light and Power Company, which he joined as a thirteen-year-old office boy in 1880 when the company was known as the United States Illuminating Company. This was two years prior to the opening of the Pearl Street station of the Edison Company and three months after the perfection of the incandescent lamp by Thomas A. Edison. In 1889 he was appointed paymaster for his company which then had become the United Electric Light and Power Company; 1891 found him assistant auditor, and eight years later he was elected to the office of assistant secretary. A year later he became secretary of the Brush Electric Illuminating Company, of which he in 1929 became president and a director. Of the United Electric Light and Power Company he was made secretary in 1905, vice-president in 1912 and general manager in 1916. In 1926 Mr. Smith was elected chairman of the board of the New York and Queens Electric Light and Power Company; in February a year ago he was made vice-president of the New York Edison Company. He has been active also in the affairs of the National Electric Light Association for many years, of which he was elected vice-president in 1919 and president in 1922. Under his presidency the association expanded considerably, Mr. Smith being largely instrumental for the formation and organization of its geographic sections. He has been chairman of many of the association's committees, and an active member of a large number of others; for sixteen years he has served as chairman of its lamp committee and is still a member of the public policy committee. In its early days he was actively connected with the Electric Vehicle Association and in 1923 was its president. This was shortly before the association became a part of N.E.L.A. activities. In addition to several other technical organizations, Mr. Smith is a member of the Electrical Association of New York, the New York Electrical Society and the Engineers' Club. In his long and assiduous service in the electrical profession he has commanded confidence as a conservative, open-minded administrator, giving particular attention to all complaints which came to him, and the maintenance of cordial public relations.

W. D. Coolidge (A'10) associate director of the research laboratory of the General Electric Company, Schenectady, N. Y., on February 24, 1932 received the Washington Award for his "scientific spirit and achievement in developing duc-

H. A. KIDDER

B. F. Kutcher Studio
KERN DODGE

A. H. KEHOE

tile tungsten and the modern X-ray tube." A native of Hudson, New York, Doctor Coolidge was graduated from Massachusetts Institute of Technology in 1896, at that time receiving his B.S. degree; in 1899, he won his Ph.D. from the University of Leipzig. At M.I.T. he has been assistant in physics, instructor in physicochemistry and assistant professor in physico-chemical research. In 1905 he associated himself with the General Electric Company and ever since 1908, when he was made assistant director has been in the research laboratory. In 1914 he received the Rumford Medal for his invention and application of the ductile tungsten. This medal is awarded biannually by both the Royal Society and the American Association of Arts and Sciences, "for the most important discovery and useful improvement" during the two years immediately preceding the date of award. He has also been the recipient of the Franklin Institute's Howard N. Potts Medal (1926) "in consideration of the originality and ingenuity shown in the development of a vacuum tube that has simplified and revolutionized the production of X-rays," and the Louis Edward Levy Gold Medal, another Franklin Institute award for professional achievement. In 1927 he received the gold medal of the American College of Radiology and the Hughes Medal of the Royal Society, London. Doctor Coolidge enjoys extensive membership in the scientific and technical groups, among them being the American Chemical Society, the American Electrochemical Society, the American Physical Society, the American Academy of Arts and Sciences, and the Washington Academy of Sciences. Also he is an honorary member of the American Roentgen Ray Society, the American Radium Society, the Radiological Society of North America, the Roentgen Society (of England), Societe de Radiologie Medicale (of France), and Nordick Forening for Medicinsk Radiologi.

H. A. Kidder, (A'06, F'29) superintendent of motive power, Interborough Rapid Transit, New York, has been elected president for 1932 of the United Engineering Trustees, Inc., joint agency of the four national engineering societies, 29 West Thirty-Ninth Street, New York, N. Y. His appointment as electrical superintendent of the Interborough Rapid Transit came in 1914, following his employment in the railway motor department of the General Electric Company; six years later he was advanced to assistant superintendent of motive power, his further advance to superintendent coming in 1921. Mr. Kidder has served the Institute in a multiplicity of committee connections including power generation, power stations, headquarters, standards, special committee on Institute prizes, the engineering profession, special committee on technical activities, executive, finance, coordination of Institute activities, Edison Medal, transportation, U.S. National committee of International Electrotechnical Commission, and meetings and papers (now technical program committee) and still is active as Institute representative to the United Engineering Trustees, American Engineering Council, on the A.I.E.E. board of examiners, law, and legislation. For three years he was on the board of directors, served one year as chairman of the Institute's New York Section, and for two years as a vice-president. He is a past-president of the New York Electrical Society, and a member of the American Electric Railway Association. At present Mr. Kidder is devoting a great deal of his time to the Professional Engineers' Committee on Unemployment, on which he is serving as chairman of the finance committee.

Kern Dodge (A'02, M'12) consulting engineer and aviation enthusiast of Philadelphia, Pa., who recently received appointment as director of public safety of the City of Philadelphia, is a native of Chicago, and was graduated from Drexel Institute in 1907. For four years, before and after school of each day, he took charge of the electric plant at the works of the Link-Belt Company, where finally in complete charge of new electrical equipment, he changed over the entire system to electric drive. He was placed in charge of the electrical equipment at the Harrison Safety Boiler Works of Philadelphia, where he later entered into a partnership with Charles Day (now of Day and Zimmerman) in a consulting engineering practise. This company subsequently became Dodge, Day and Zimmerman, and Mr. Dodge's work was chiefly in connection with public utility properties, his earlier consulting work having been the design, layout, and construction of power plants, transmission lines and substations. A registered professional engineer in the State of Pennsylvania, Mr. Dodge now is a director of the Link-Belt Company, a member of the New York Electrical Society, the American Society of Mechanical Engineers, and the Illuminating Engineering Society. He is said to be an expert in the field of aviation, and the first engineer in the history of Philadelphia to be appointed director of public safety. This also is the first political appointment Mr. Dodge has had.

A. H. Kehoe (A'12, F'25) electrical engineer of the United Electric Light and Power Company was one of those chosen vice-president of the New York Edison Company at a recent meeting of its board of directors. As superintendent of transmission and distribution and for over nine years electrical engineer of the United Electric Light and Power Company, as well as a member of several important subcommittees of the electrical apparatus committee of the National Electric Light Association, Mr. Kehoe has established for himself a reputation of capability. His estimable record with the United Electric Light and Power Company started in 1911, in the laboratory on special investigations and design of new equipment. He progressed to important work in the meter department, and thence to the engineering department, where his duties were in connection with substation design and construction, also distribution system engineering in the arrangement of cable systems and service, transformers on network systems and the location and elimination of faults, and the maintenance of the continuity of service. He also worked on transmission system design and protection. He has contributed to technical literature, setting forth interesting and instructive phases of his own valuable experience. In his endorsements to the grade of Fellow was the commentary "his engineering work is admirable and his ethical standards of the highest."

M. S. Sloan (A'07, F'30) for the past number of years identified as president, trustee and director of the several companies of the Consolidated Gas Company system, at a recent meeting of the board

of directors tendered his resignation. Mr. Sloan's professional career includes a rapid rise from humble beginnings with small southern power companies to early service with the General Electric Company and assistant to the president of the power company at Birmingham, Ala. Thence he went to New Orleans in 1917, returning from that point to become assistant to the president of the New York Edison Company, and finally succeeding Nicholas F. Brady (A'01) as president of the latter company.

R. H. Tapscott (A'18, F'29) who has just been elected a vice-president of the New York Edison Company, became electrical engineer of the Edison company in 1925. His first appointment to office there, following his resignation from the General Electric Company, took place in October 1917, when he was made assistant chief electrical engineer. Mr. Tapscott's activity in committee work, both in the Institute and other societies, has been well known. In the A.I.E.E., he has served as a member of the executive committee of the standards committee for a number of years, on the electrical machinery committee one year, on the power transmission and distribution committee two years, and as chairman of the headquarters committee since 1928; in 1930 he completed a term as chairman of the New York Section. Besides, he has been chairman of the electrical apparatus committee of the National Electric Light Association, a member of its engineering national committee, and as a member of the electrical advisory committee is at present representing the light and power group. Mr. Tapscott has at all times evidenced not only high engineering ability, but a fine sense of professional ideals.

S. N. Bose (A'13, M'22) who since 1926 has been assistant, and later, deputy chief electrical engineer of the Tata Iron and Steel Company, Ltd., Jamshedpur, India, now is chief electrical engineer of that organization. Notice in the December issue of Electrical Engineering implied that Mr. Bose had gone to India only recently; the above therefore serves as a correction to the earlier statement. Mr. Bose's New York connection immediately prior to his going to India in 1926 was with the J. G. White Engineering Corporation, his affiliation with the Cazenovia Electric Company, Cazenovia, N. Y., having preceded that with J. G. White.

Frederick Krug (A'17, M'25) vice-president and general manager of the Porto Rico Railway, Light and Power Company, San Juan, has been elected president of the Chamber of Commerce of Porto Rico, affiliated with the Chamber of Commerce of the United States. Mr. Krug is president also of Porto Rico Service, Incorporated, a business man's organization which promotes new industries on the island and exhibitions on the mainland. He is an able member of the governor's insular employment relief committee and of other organizations for civic welfare.

A. W. Lee (A'08) who has been serving the Louisville Gas and Electric Company in the capacity of general superintendent, now has become vice-president in charge of operation to succeed Lewis Starr Streng (A'04, F'26) recently deceased. In addition to his new duties as vice-president, Mr. Lee's name has been added to the directorate of the Louisville company. He also has been very active in the field of aviation, and was chairman of a special committee appointed by former Governor Sampson to draft the present state aviation laws.

Kaiden—Keystone Studios

R. H. TAPSCOTT

Sannosuke Inada (A'22) one of the most distinguished of Japanese engineers, and one who since 1925 has served as director general of telegraph and telephone engineering of the Teishinsho, or department of communication of Japan, retired on January 11, 1932. He is well known in both American and European communication circles, and his work with the Teishinsho began in 1900 when he was graduated from the College of Tokio Imperial University. Since 1925 he has been also a professor of Waseda University.

Henry Snyder (A'24) recently elected president of the New York and Queens Electric Light and Power Company, New York, N. Y., has been interested in the public utilities of Queens ever since 1899 when he assisted in merging two Newtown and two Flushing companies into the New York and Queens Gas and Electric Company. He was president of the New York and Queens Gas Company, resigning to devote all his attention to the development of the electric company, of which he became vice-president several years ago.

Sir Oliver Lodge, scientist, has been made the recipient of the Faraday Medal presented by the council of the Institution of Electrical Engineers, of Great Britain. He is 80 years old. Sir Oliver's experiments with high frequency oscillations led to the discovery and invention in 1894 of the coherer which contributed to the advancement of wireless telegraphy. The Faraday Medal is awarded not more than once a year for notable scientific or industrial achievement in electrical engineering.

T. S. Burns (A'31) has been made senior engineer, United States Engineers Office, Huntington, W. Va. Mr. Burns in 1930 was senior hydroelectric engineer, U.S. War Department, in charge of preparation of power report for the Pittsburgh district, and prior to that was estimating engineer with the Pennsylvania Water and Power Company, Baltimore, Md., in charge of estimates on the Safe Harbor project, Susquehanna River.

B. S. Bessesen (M'27) an associate electrical engineer in the United States Civil Service, who has been acting superintendent of the Muscle Shoals Development, Ala., for the past year, now has received his appointment as superintendent. Mr. Bessesen has held responsible positions in power development projects in the west and from 1922 to 1924 was instructor in electrical engineering at Oregon State College, Corvallis, Ore.

E. S. Fitz (A'16) manager of production and transmission for the past year or so, for the Virginia Electric and Power Company, Richmond, Va., recently was appointed general manager of the electric department for the entire system which serves tidewater Virginia and northeastern North Carolina. His new position gives him charge of distribution as well, and he will continue to make Richmond headquarters.

E. V. Sayles (A'23, M'30) who has been investigations engineer for the electrical engineering department of Allied Engineers, Inc., Jackson, Mich., now has become general engineer for the Commonwealth and Southern Corporation, in Jackson. Mr. Sayles has served on the underground systems committee of the N.E.L.A. and is a member of the Association of Iron and Steel Electrical Engineers.

A. H. Dickinson (A'30) formerly research assistant in the department of fuel and gas engineering, Massachusetts Institute of Technology, Cambridge, Mass., has joined the International Business

Machine Corporation, New York, N. Y., as assistant engineer. While a member of the M.I.T. research staff, Mr. Dickinson developed a method for the more accurate calibration of high pressure gas meters.

H. P. Charlesworth (M'22, F'28) vice-president of the Institute and of the Bell Telephone Laboratories, Incorporated, New York, N. Y., and A. W. Berresford (A'94, F'14) past-president of the Institute and managing director of the National Electrical Manufacturers Association, New York, N. Y., are two of the recently elected board of trustees of United Engineering Trustees, Inc.

Daniel W. Mead (A'11, F'13) consulting engineer, New York, N. Y., and Madison, Wis., and professor of hydraulics and sanitary engineering at the University of Wisconsin, at the annual meeting of the American Society of Civil Engineers, held in New York at the Engineering Societies Building, January 20, 1932, was made an honorary member of that organization.

R. W. Sorensen (A'07, F'19) professor of electrical engineering at the California Institute of Technology, Pasadena, Calif., recently was made a member of the board of consulting engineers for the Metropolitan Water District of Southern California. The February issue of Electrical Engineering incorrectly referred to this appointment as one to the board of directors.

J. A. Cook (A'15, F'30) superintendent of the electrical department of the Lynn Gas & Electric Company, Swampscott, Mass., recently was elected chairman of the New England System Operators' Club, and S. C. Jacoby (A'21) superintendent of transmission and distribution, of the Montaup Electric Company, Fall River, Mass., was chosen as the club's secretary.

A. E. Kennelly (A'88, F'13) past-president of the Institute and professor emeritus of electrical engineering, Harvard University and Massachusetts Institute of Technology, Cambridge, Mass., recently was elected an honorary member of the German Elektrotechnischer Verein, and also of the Japanese Institute of Electrical Engineers.

R. M. Garth (A'24) who was distribution engineer for the Knoxville Power and Light Company and associated companies, the Tennessee Public Service Company and Holston River Electric Company, now has been made assistant electrical engineer, Navy Department, Bureau of Yards and Docks, Washington, D. C.

L. S. Horner (A'04) formerly president of Niles-Bement-Pond and Kissel Kinnicutt and Company, New York, N. Y., now has removed to Bridgeport, Connecticut, as vice-president of the Bullard Company. During 1930-31, Mr. Horner was a director of the United States Chamber of Commerce.

L. M. Klauber (F'23) heretofore vice-president and general superintendent of the San Diego Consolidated Gas and Electric Company a subsidiary of the Byllesby Engineering and Management Corporation of Chicago has been chosen vice-president in charge of operation for the San Diego company.

Mabel MacFerran (A'28) who has been technical assistant to the operating engineer of the Southern California Edison Company, Los Angeles, Calif., now has been made assistant electrical engineer of the Metropolitan Water District of Southern California, Los Angeles, Calif.

G. C. WARD

W. J. Miller (A'19, M'26) resigned as dean of engineering and professor of electrical engineering at Texas Technological College to accept the position of professor and head of the department of electrical engineering at the University of North Carolina, effective January 1932.

C. O. Von Dannenberg (A'06, M'30) previously serving the Electric Management and Engineering Corporation, New York, N. Y., as assistant electrical engineer, now has joined the engineering department of the Pennsylvania Central Light and Power Company, Altoona, Pa.

C. G. Jones (A'16, M'18) has left the Westinghouse Electric and Manufacturing Company's head offices at East Pittsburgh, Pa., and his work as inductive heating engineer, to become special engineer for the Youngstown Sheet and Tube Company, Youngstown, Ohio.

E. W. Morris (A'29) has been transferred to the Westinghouse Electric and Manufacturing Company's San Francisco office in the capacity of industrial application engineer. Previously Mr. Morris was with the company's Los Angeles office as general engineer.

C. L. Farrar (A'23) who has been serving as associate professor of electrical engineering, University of Arkansas, Fayetteville, Ark., now is engaged in the electrical engineering department of the school of electrical engineering, University of Oklahoma, Norman, Okla.

C. N. Brubaker (A'19, M'29) in the past managing engineer of the transformer department, General Electric Company, Erie, Pa., has added his name to the roll of the Institute's Pittsfield Section as a result of his recent transfer to the company's Pittsfield office.

F. J. Stevens (A'12, M'27) who has been serving as superintendent of the Parkersburg (W. Va.) plant of the Porcelain Products, Incorporated, recently identified himself with the American Lava Company, Chattanooga, Tenn., as production engineer.

R. B. Tenney, Jr. (A'10) recently joined the Power Cost Engineering and Appraisal Corporation of San Antonio, Tex., as its consulting engineer in Dallas. His previous affiliation was as engineer of the Texas Power and Light Company, also at Dallas.

Alexander Nyman (A'19, M'26) who heretofore has served the Radio Patents Corporation, New York, N. Y., as vice-president, resigned from that position and now is consulting engineer for the Shortwave and Television Corporation, Boston, Mass.

W. C. Woodson (A'22) formerly assistant engineer, meter department of the New York Edison Company, now is assistant engineer in the meter and test department of the United Electric Light and Power Company, Irving Place, New York, N. Y.

E. D. Wood (A'21, M'26) formerly electrical operating engineer for the Louisville Gas and Electric Company, now has been advanced to the office of general superintendent, to succeed A. W. Lee (A'08) who has assumed new executive duties.

F. D. Spofford (A'23) previously traffic engineer for the Wheeling Traction Company, (W. Va.) has been selected assistant to the president of the Blue Ridge Lines, the bus subsidiary of the West Penn Electric Company of Pittsburgh, Pa.

G. C. Ward (M'24) was recently elevated to the rank of senior vice-president of the Southern California Edison Company, Ltd., Los Angeles, Calif., as

announced in ELECTRICAL ENGINEERING for February 1932, p. 140.

R. J. CLINGERMAN (A'29) has resigned from his work with the Consolidated Gas Electric Light and Power Company of Baltimore, Md., and made new connections in the sales department of the Ochiltree Electric Company at Pittsburgh, Pa.

R. M. ARNOLD (A'25) who was chief engineer of the radio division of the United Air Cleaner Company, Chicago, Ill., recently was elected vice-president and chief engineer of the United Air Cleaner Corporation of Chicago.

E. F. VENN (A'28) formerly inspector of the maintenance engineering department of the Western Electric Company, Kearny, N. J., has gone to Clewiston, Fla., as assistant engineer for the United States Sugar Corporation.

G. H. BUCHER (M'24) assistant general manager of the Westinghouse Electric International Company, New York, N. Y. recently was elected its vice-president and general manager. His headquarters still will be in New York City.

A. L. WOODHOUSE (A'02) vice-president of the Dixie Power Company, Cedar City, Utah, has removed to Palo Alto and is now vice-president and manager of the Central Mendocino County Power Company, Willits, Calif.

ERLAND JOHNSON (A'25) who has been mechanical and electrical engineer for the Detroit Rock Salt Company, Detroit, Mich., now has engaged as superintendent of the Avery Salt Company, Avery Island, La.

W. H. SPENCER (A'27) who as assistant secretary to Montreal Light Heat and Power Consolidated has been supervising accident prevention work for this company, now will specialize in safety engineering.

A. J. DUNCAN (A'09) previously president and general manager for the Fort Worth Power and Light Company, Fort Worth, Texas, has been chosen president of the Texas Electric Service Company of that city.

MELVIN BLOCK (A'30) who has been sales engineer of the Wagner Electric Corporation, at Pittsburgh, Pa., now has joined the American Shoe Machinery and Tool Company, St. Louis, Mo., as a salesman.

DAVID NEMETZ (A'28) who was sales engineer for Electrical Distributors, Vancouver, B. C., Can., recently was made president of the Standard Electric and Radio Company of Vancouver.

M. K. LOCK (A'25) who has been serving the firm of Lock, Lang & Austin, Irvington, N. J., as radio engineer, now is chief engineer at the WNJ radio station of Newark, New Jersey.

P. I. DOTY (A'30) previously of the industrial department, General Electric Company, Schenectady, N. Y., has been transferred to the company's San Francisco office.

Obituary

HAROLD BABBITT SMITH (A'91, F'13) junior past-president of the Institute and for 35 years head of the electrical engineering department of Worcester Polytechnic Institute, died February 9, 1932, after an extended illness of almost a year's duration. Doctor Smith was born at

H. B. SMITH

Barre, Massachusetts, May 23, 1869. Graduated from Cornell University with the degree of M.E. in E.E. in June 1891; he remained as graduate student until December 1891. In January 1892 he was appointed professor of electrical engineering in charge of the department at the University of Arkansas. Resigning this position later the same year, he became head designer and electrical engineer for the Elektron Manufacturing Company, Springfield, Mass. From September 1893 to June 1896 he was director of the department of electrical engineering at Purdue University. He had held his position as professor of electrical engineering and director of the department at Worcester Polytechnic Institute ever since 1896.

Until 1902 Doctor Smith retained a connection with the Elektron Manufacturing Company as consulting engineer doing consulting work for several other organizations at various times. Since 1905 he had served as a consulting engineer for the Westinghouse Electric and Manufacturing Company of East Pittsburgh, Pa.

In 1904 he was chairman of the international group, jury of awards in electrical engineering at the St. Louis Exposition. During the years 1917-19, he was an associate member of the Naval Consulting Board and consultant of the special board of the Navy on anti-submarine work. He has been a pioneer in the development of high-voltage power transmission systems and equipment, carrying on many researches involving advanced conceptions of dielectric phenomena and stress distribution. He has obtained numerous patents, and has contributed many papers to the transactions of the engineering societies and other technical publications.

Doctor Smith resigned his educational chair at Worcester Polytechnic Institute effective June 1931. As one well known in engineering and education he always has carried forth a multiplicity of duties in these fields. His share in Institute activities has been abundantly represented by service on several of its committees simultaneously, including: law 1920-21; electrophysics and student branches 1920-27; instruments and measurements 1921-22; educational 1922-27; sections 1922-28; Edison Medal 1924-26, 1929-30, 1930-32; research, coordination of Institute activities, and meetings and papers 1924-27; code of principles for professional conduct 1928-29; executive 1929-31; and public policy 1930-31. He was appointed also to the John Fritz Medal board of award for 1929-33, the U.S. national committee of the I.E.C., the Chas. A. Coffin Fellowship and Research Fund committee 1929-30, and the American Engineering Council 1930-31. His other memberships included American Society of Mechanical Engineers (Member), Institution of Electrical Engineers (Great Britain), Society for the Promotion of Engineering Education, American Association for the Advancement of Science, Sigma Xi, and Tau Beta Pi. In 1929 Doctor Smith had two honorary degrees conferred upon him; Doctor of Engineering from Purdue University and Worcester Polytechnic Institute.

MAX TOLTZ (M'22) since 1907 a prominent consulting engineer with offices in St. Paul, Minn., died at his home there January 11, 1932. Mr. Toltz was a native of Koeslin, Germany, where he attended the Koeslin Royal Gymnasium, later winning his civil engineering degree from the Royal Polytechnikum in Berlin, in 1878. A degree of doctor of engineering was conferred upon him in 1924 by the Ramsey Institute of Technology, St. Paul, Minn. After graduation from the Royal Polytechnikum, he served a short apprentice with a Berlin firm and before coming to the United States in 1882 was connected with the Prussian government. In 1889 he became a naturalized American

citizen, and devoted the first 25 years spent in the United States to the development of railroads, especially in the northwest. The St. Paul, Minneapolis and Manitoba (later the Great Northern) railway benefited by Mr. Toltz' efforts and energy, his final office with it being engineer in charge of motive power, a position achieved by step-by-step promotions from the position of draftsman. He was consultant in mechanical engineering for the Winnipeg workshops of the Canadian Pacific Railway and also for the Jersey City workshops of the Erie railroad; he was vice-president and general manager for the Manistee and Grand Rapids railroad. During the period 1907-10 the electrification of the Great Northern, the Northern Pacific, Butte, Anaconda & Pacific, and Chicago, Milwaukee & St. Paul railroads deeply engrossed him, as did also work on the ore docks for the Great Northern, Northern Pacific & Soo lines. In 1910 he organized the Toltz Engineering Company of St. Paul, of which he was president, an office which he held also in the successor company, Toltz, King & Day, Inc., formed in 1918. Mr. Toltz retired from active business in 1928. During the World War, from a captaincy which he had held for many years in the Minnesota National Guard, he was given the rank of major in the construction division of the Quartermaster Corps, and in this capacity supervised the construction of General Hospital No. 2, at Fort McHenry, in the city of Baltimore, Md. He was a valued member of the St. Paul Interprofessional Institute, a director of its national board; a vice-president of the American Society of Civil Engineers, a member of the American Railway Master Mechanics Association and of the American Society of Military Engineers. He has served as president of both the Engineering Society of St. Paul and of the Federation of Architectural and Engineering Societies of Minnesota. He was also a member of the Vereines Deutscher Ingenieure. Of the American Society of Mechanical Engineers, which he has served in various capacities since 1904, he has been manager, vice-president, and organizer and first chairman of its St. Paul local section, a member of its executive committee, the 1932 nominating committee, and its committee of awards. The press reports that student loan funds of $15,000 each have been left by Mr. Toltz to the civil and electrical engineering professions, the income from these amounts to be administered by the parent organizations. In 1925 a similar fund was established by him for the mechanical engineers.

Joens Elias Fries (A'04, F'15) chief engineer of the Tennessee Coal, Iron and Railroad Company, Birmingham, Ala., died January 23, 1932, after a prolonged illness. He was a native of Sweden, and was educated there, being graduated from the College of Upsala in 1894 and from the Royal Technical Academy in Stockholm in 1898, with degrees in civil and electrical engineering. In 1900 he engaged with a Stockholm firm manufacturing telephone apparatus; then with the General Swedish Electric Company as estimator for plants of every kind. Following this experience he was appointed superintendent of the Holmia Electric Company of Stockholm, in which capacity he remained until 1903. The next uear he came to America and joined the New York Edison Company, remaining with it briefly before identifying himself with Westinghouse, Church, Kerr and Company for drafting work in connection with the construction of the Long Island railroad electrification. Through the period 1905-07 he was commercial engineer for Allis Chalmers Company, then left for the Canadian General Electric Company, where he became engineer of power plants and power transmission. In 1908 he joined the Crocker-Wheeler Company, spending a year and a half in charge of the estimating department, a like period as industrial engineer, two years as Pacific Coast engineer and the rest of his stay with that company as assistant chief engineer. September 1916 he became chief electrical engineer for the Tennessee Coal, Iron and Railroad Company, a subsidiary of the U.S. Steel Corporation, remaining with these interests up to the time of his death. He was a member of the Association of Iron and Steel Electrical Engineers, the American Society of Mechanical Engineers, the American Association for the Advancement of Science and the American Society for Steel Testing. He also had been a member of the Engineers Club of New York since 1909, and of the Engineers Club of San Francisco since its inception. Mr. Fries was 56 years old at the time of his death.

William Dutton Pomeroy (A'99, M'21) general manager, vice-president and director of the Goulds Pumps, Inc., Seneca Falls, N. Y., died January 6, 1932, after an illness of a year's duration. He had been with the Goulds company since 1908, when he became its general superintendent. His birthplace was Utica, N. Y. (1874). After graduation from Cornell University in 1896, with an M.E. degree, he spent a year as draftsman of the Bossert Electric Construction Company at Utica, leaving it to continue in electrical construction work with the Belt Line Street Railroad Company of that city. He then removed to Akron, Ohio and joined the Akron Electric Manufacturing Company as a draftsman, to be advanced a year later to the office of superintendent and engineer. In this position he remained until 1901, when he was made assistant chief draftsman for the Bullock Electric Manufacturing Company of Cincinnati, Ohio, becoming general superintendent in 1903 and remaining such until 1907. The last year of this period he was also superintendent of the electrical department of the Allis Chalmers Company, Milwaukee, Wis. This was the position from which he went to the Goulds Manufacturing Company as its general superintendent. Besides his Institute affiliations, Mr. Pomeroy belonged also to the American Society of Mechanical Engineers and the American Institute of Mining and Metallurgical Engineers. By the former he was awarded the Melville Medal for a paper which he prepared jointly with Prof. Herman Diedrichs of Cornell University on the subject of "The Occurrence and Elimination of Surges or Oscillating Pressures in Discharge Lines from Reciprocating Pumps."

Alexander Jay Wurts (A'92, M'92) electrical engineer and a member of the first faculty of Carnegie Institute of Technology, died at his home in Pittsburgh, Pa., January 21, 1932, in the 71st year of his age. His birthplace was Carbondale, Pa. He attended Yale University which in 1883 conferred his Ph.D. upon him. The following year he received his M.E. degree at Stevens Institute of Technology. He then spent two years in the Polytechnikum, Hanover, Germany, and in the fall of 1886 began work with the United States Electric Lighting Company. December of the same year he was placed in charge of the factory of the Julien Electric Company, Camden, N. J., and a year later joined the Westinghouse interests. For eleven years Mr. Wurts was research engineer for George Westinghouse in the development of the Nernst lamp, arresters, etc. His identification with the Westinghouse Electric and Manufacturing Company carried over a period of twenty years; in the course of events he met Andrew Carnegie, and through this acquaintance was elected as the first faculty member of the Carnegie Technical School, which later became known as the Carnegie Institute of Technology. After four years as professor of engineering research, Mr. Wurts gave up teaching, retaining however the chairmanship of the student welfare service of Carnegie Institute. Through the Franklin Institute, Mr. Wurts received the John Scott Medal from the city of Philadelphia for his work with lightning arresters and his discovery of five non-arcing metals. He was a member of the American Philological Society.

John Robertson Cowley (A'25, M'29) city electrical engineer, City of Saskatoon, Canada, and past-chairman of the Institute's Saskatchewan Section, died January 16, 1932. He was born in Dundee, Scotland, September 11, 1882, and his early education was obtained at the Harris Academy, in Dundee. His technical training came through two years electrical and mechanical engineering course at the Hariot-Watt College, Edinburgh, and the University of Edinburgh, Scotland. He then served a three-year apprenticeship with an electrical engineering firm in Dundee before joining the Corporation Electricity Works, City of Perth, Scotland. From 1904 to 1907 he was assistant engineer with a municipal tramways company of Scotland, afterwards becoming engineer in charge of distribution for the Clyde Valley Electrical Power Company, Glasgow, Scotland. In 1911 he came to Canada as chief operator for the Canadian Light and Power Company, Montreal. This led to his work with the City of Saskatoon, first as assistant city electrical engineer and then as city electrical engineer, with full charge of generation, distribution, and accounting in the department. His assistantship covered a period of rapid expansion and the results which he obtained through his own leadership were most noteworthy. The city installation included a 10,000-kw. plant and distributing system, in connection with which practically all design and construction devolved upon Mr. Cowley during his term of office, which extended well over a full period of twelve years.

William H. Fernholz (M'21) sales engineer of the Electrical Engineer's Equipment Company, at Milwaukee, Wis., died January 25, 1932. He was born in Westphalia, Germany in 1883 and after a full four-year course at a college of engineering in Germany, following earlier training at a technical school in Thuringia, Germany, he came to the United States in 1906 and entered the switchboard department of the Bullock Works, Cincinnati, Ohio. From this first position he changed two years later to drafting work with the Vilter Manufacturing Company, the Johnson Service Company and the Allis-Chalmers Company, respectively, all of Milwaukee; in 1817 he was advanced to the position of chief draftsman of the Federal Rubber Company of Milwaukee, and later in that same year, he became district manager for sales and engineering of the Electrical Equipment Company of Chicago with offices in Milwaukee. While with the Allis-Chalmers Company, Mr. Fernholz did considerable design work in the building of switchboards; also consulting engineering and layout work. He did a valuable amount of important engineering in conjunction with electric power plants, in charge of high-voltage line layout and installations and special design and on construction of switchboards for industrial processes, as well as for the Chinese government. He had been a member of the Institute's Milwaukee Section for some time, and as such took active part in Institute operations.

William Harrison Bullock (A'16) for a number of years general engineer of the Westinghouse Electric and Manufacturing Company, Denver, Colo. and past-chairman of the Institute's Denver Section, died January 21, 1932, in his fiftieth year. Mr. Bullock was a graduate of the University of Colorado from which he obtained his B.S. in E.E. in 1904. At the time of his death he was associated with H. S. Sands, consulting engineer in Denver. His service with the Westinghouse company dated from an apprenticeship in 1904, from which time he progressed consecutively through the sales and engineering department to industrial motor application in coal and metal mining and miscellaneous shop applications; also the application of electrical apparatus to agricultural situations to be found in the Rocky Mountain region. Mr. Bullock held membership also in the Electrical League of Colorado.

Bradley Lyon Child (A'23) connected with the long lines engineering department of the American Telephone and Telegraph Company, New York, N. Y., as transmission engineer, died January 20, 1932, after a brief illness. He had served this company for 27 years. Born at Meriden, Connecticut, in 1884, Mr. Child came to Brooklyn, N. Y., graduating from Brooklyn Polytechnic Institute with the 1903 class in steam and machine design, and continuing with a special course which he followed by further study on electrical subjects. Since coming to New York, he has always been a resident of Brooklyn. Immediately following his technical studies, he joined the American Telephone and Telegraph Company in New York.

Local Meetings

Future Section Meetings

Akron

March 8—Electrical Refrigeration and Air Conditioning, by W. M. Timmerman, Gen. Elec. Refrig. Co. Movies. Meeting to be held at Ohio Pwr. Co., Canton, preceded by dinner at Elks Club.

April 12—The Electrical Industry and Some Problems of the Institute, by Dr. C. E. Skinner, pres. A.I.E.E., asst. director of engg., Westinghouse Elec. & Mfg. Co. Movies.

Baltimore

March 18—Subject to be announced. Speaker: Capt. Greenlee, Director of Naval Experimental Station.

April 15—Subject to be announced. Speakers from Western Elec. Co.

Chicago

March 17—Coordination of Insulation, by F. E. Andrews, Pub. Serv. Co. of Northern Illinois.

Cleveland

March 24—Joint meeting with Case Sch. of Applied Science Branch. Speaker: Dr. Dayton C. Miller.

April 21—Electric Refrigeration and Domestic Air Conditioning, by W. M. Timmerman, Gen. Elec. Co.

Dallas

March 21—Underground Construction and Cable Developments, by John Oram, Dallas Pwr. & Lt. Co. Meeting to be held in Fort Worth, Texas.

Detroit-Ann Arbor

March 15—Vacuum Tubes and Their Application, by E. H. Vedder, Westinghouse Elec. & Mfg. Co.

April 19—Commercial Metering of Electric Energy, by A. S. Albright, Detroit Edison Co.

Lehigh Valley

March 18—Research—Industry's Health Insurance, by S. M. Kintner, Westinghouse Elec. & Mfg. Co.

Louisville

March 18—Men Who Have Made Electrical Engineering History. Meeting under the auspices of students at Univ. of Louisville. Demonstrations.

April 15—Inspection trip to Bowman Field Airport. Fundamentals of Plane Construction and Flight, by A. W. Lee, Louisville Gas & Elec. Co.

Lynn

March 9—Miracles in Nature, by Dr. Pillsbury.

March 16—Local convention. Subject: Recent Developments in the Thomson Research Laboratory, Gen. Elec. Co.

March 26—Inspection trip.

Pittsburgh

March 8—Joint meeting with Association of Iron & Steel Elec. Engrs., and Engineers' Soc. of Western Penn.

April 12—Television. Demonstrations. Joint meeting with I.R.E.

Pittsfield

March 15—Competitive meeting with Schenectady Section.

Seattle

March—Annual joint meeting of Founder societies.

April 19—Joint meeting with Student Branch at Univ. of Washington.

Spokane

March 25—Joint meeting with Student Branches at State Col. of Washington and Univ. of Idaho. Papers by local members and students.

April 22—New Developments in Oil Circuit Breakers, by J. F. Spease, Gen. Elec. Co.

Toledo

March 18—Inspection trip through Bldgs. 6 and 7 of the Rossford plant of the Libbey-Owens Ford Co.

April 15—Problems in the Design of Large Turbo-Alternators, by S. H. Mortensen, Allis Chalmers Co.; Application of Electricity in Industry, by R. E. Paxton, Toledo Edison Co.

Vancouver

March 7—Students' night.

April 4—Switchgear, by W. D. Robertson, Canadian Gen. Elec. Co., Ltd.

Past Section Meetings

Akron

Television, by Dr. J. O. Perrine, Amer. Tel. & Tel. Co. Illus. Dec. 8. Att. 1,600.

X-Ray Inspection of Welds, by Ancel St. John, St. John X-Ray Serv. Corp. Jan. 12. Att. 45.

Atlanta

The Electrical Industry of Today, by Dr. C. E. Skinner, pres. A.I.E.E., asst. director of engg., Westinghouse Elec. & Mfg. Co. Joint meeting with A.S.M.E. Sec. Jan. 6. Att. 160.

Baltimore

Electrons at Work and at Play, by Dr. Phillips Thomas, Westinghouse Elec. & Mfg. Co. Demonstrations. Dinner. Jan. 15. Att. 975.

Boston

Photoelectric Cells, by A. R. Olpin, Bell Tel. Labs. Inc. Demonstrations. Moving pictures describing the life of Thomas A. Edison. Jan. 12. Att. 220.

Chicago

The Control of Vibration and Noise in Power Stations, by P. E. Stevens, Byllesby Engg. & Mgmt. Corp. Demonstrations. Joint meeting with the Western Soc. of Engrs. Jan. 7. Att. 150.

Cincinnati

Industrial Applications of Photoelectric Cells, by E. H. Vedder, Westinghouse Elec. & Mfg. Co. Illus. Dinner. Dec. 10. Att. 110.

Talking Movies—Historical and Present Day Developments, by F. L. Hunt, Bell Tel. Labs. Inc. Illus. Jan. 14. Att. 330.

Cleveland

The Electrical Industry of Today, by Dr. C. E. Skinner, pres. A.I.E.E., asst. director of engg., Westinghouse Elec. & Mfg. Co. Jan. 21. Att. 126.

Connecticut

Vacuum Tubes and Some of Their Applications, by J. D. LeVan, Ratheon Co., F. G. Kelly, Engg. and Research Corp., and H. Raymond, Stanley Works. Demonstrations. Jan. 19. Att. 142.

Dallas

Joint meeting with Southern Methodist Univ. Branch. Following papers presented by students: Thyratron Tubes, by J. V. Melton; Deion Circuit Breaker, by J. W. Emery; Recent Developments in Radio Receiving Tubes, by J. N. Walker and D. Ramsey. Jan. 18. Att. 60.

Denver

Four Films—"Earl Carroll in the House of Magic," "Mica Insulation by Machine Methods," "Mazda Lamps Preferred," and "The Electric Ship." Dinner. Jan. 15. Att. 70.

Detroit-Ann Arbor

The Business of Being a Woman, by Miss S. M. Sheridan, Detroit Edison Co. Dinner, dancing, and bridge. Jan. 19. Att. 91.

Erie

The Theories of Ether Waves and Radiation, by W. E. Forsythe, Gen. Elec. Co. Illus. Jan. 19. Att. 125.

Houston

Joint meeting with Rice Inst. and A. & M. Col. of Texas Branches. First and second prizes awarded to C. K. Beyette, Rice Inst., and C. C. Nash, A. & M. Col., respectively. Jan. 16. Att. 86.

Indianapolis-Lafayette

Arc Welded Steel Houses, by R. G. Eaglesfield, Lincoln Elec. Co. Illus. Dinner. Jan. 15. Att. 30.

Ithaca

The Present Economic Situation, by Dean Dexter S. Kimball, Cornell Univ. Joint meeting with Cornell Univ. Branch. Dec. 11. Att. 60.

Los Angeles

Aerial Map Making, by L. T. Eliel, Fairchild Aerial Surveys, Inc.; Airport Signaling, by Capt. E. Deeds, Commanding Officer, 478th Pursuit Squad. Dinner. Jan. 12. Att. 250.

Louisville

Practical Application of Light Sensitive Cells, by E. H. Vedder, Westinghouse Elec. & Mfg. Co. Demonstrated. Jan. 22. Att. 350.

Lynn

Mining of Diamonds in Africa, by Dr. Palache. Inspection of the mineral and glass flower exhibits at the Peabody Museum, Harvard Univ. Jan. 16. Att. 150.

Adventures in Science, by E. L. Manning, Gen. Elec. Co. Jan. 8. Att. 850.

Gas Compression and Application of General Electric Compressors, by R. P. Mansfield, Gen. Elec. Co. S. N. F. Hedman described the various types of compressors manufactured by Gen. Elec. Co. Superchargers, by S. A. Moss, Gen. Elec. Co. Jan. 20. Att. 175.

Madison

The Industrial Application of Electron Tubes, by L. L. Ludwigsen, Gen. Elec. Co. Discussion. Dinner. Jan. 20. Att. 47.

Memphis

The Electrical Industry of Today, by Dr. C. E. Skinner, pres. A.I.E.E., asst. director of engg., Westinghouse Elec. & Mfg. Co. Jan. 8. Att. 65.

Mexico

B. E. Arias described the electrically operated bridge spanning the Panuco River at Tamos on the lines of the National Ry. of Mexico. Illus. Jan. 19. Att. 40.

Milwaukee

What is Best for the Engineer, by E. S. Nethercut, director and secy. Western Soc. of Engrs. Joint meeting with Western Soc. of Engrs. Dinner. Dec. 16. Att. 250.

The Milwaukee Vocational School—Its Scope and Object, by R. L. Cooley, director. Moving pictures. Dinner. Jan. 20. Att. 125.

Minnesota

Informal talks by Prof. J. M. Bryant, K. J. Mertz, R. Reinbold, O. Gaarden, E. H. Hagensick, E. J. LeBlond, and A. C. Willard. Inspection trip through the Northern States Pwr. Co. bldg. Refreshments. Jan. 27. Att. 40.

Niagara Frontier

Communication in the Aviation Industry, by E. I. Pratt, Western Elec. Co. Illus. Jan. 15. Att. 175.

Pittsfield

Capturing Wild Animals, by Frank Buck. Dinner. Dec. 1. Att. 1,375.

Electrical Instruments as an Aid to Aviation, by C. F. Green, Gen. Elec. Co. Dinner. Dec. 15. Att. 220.

Soviet Russia and Eastern Europe, by Wm. C. White. Dinner. Jan. 5. Att. 1,100.

Foreign Power Systems, by Philip Sporn, Amer. Gas & Elec. Co. Illus. Dinner. Jan. 19. Att. 170.

Jungle Gods, by Capt. Carl Von Hoffman. Feb. 2. Att. 1,350.

Portland

The Men and the System Behind the Five-Year Plan, by G. W. Freide. Jan. 19. Att. 143.

Providence

Synchronous Driven Electric Clocks and System Regulation from Their Use, by H. E. Warren, Warren Telechron Co. Demonstrations. Jan. 12. Att. 50.

St. Louis

A New Type of Silent Fan, by Prof. W. L. Upson, Washington Univ. Demonstrations. Jan. 20. Att. 114.

San Antonio

The Eagle Pass Hydro Plant, by C. L. Dowell, Central Pwr. & Lt. Co. Jan. 18. Att. 32.

San Francisco

New and Interesting Developments in the Electrical Field, by A. W. Copley, Westinghouse Elec. & Mfg. Co., and W. C. Smith, Gen. Elec. Co. Illus. Michael Faraday, by Wm. Hudgins, student, Univ. of Calif. Dinner. Jan. 22. Att. 112.

Sharon

A Beam of Light, by J. M. Kelch, Gen. Elec. Co. Jan. 19. Att. 220.

Southern Virginia

Business meeting. Election of officers as follows: Cecil Gray, chairman; E. L. Lockwood, Secy.-Treas.; L. W. Webb and W. R. McCann, members, exec. committee. Electrical Pioneering in Brazil, by W. R. Worth. Dinner. Jan. 21. Att. 10.

Spokane

Teletypewriters—The Modern Method of Communication, by R. J. Morgan, Pacific Tel. & Tel. Co., assisted by W. M. Allen, Home Tel. & Tel. Co. Jan. 22. Att. 91.

Springfield

Thyratrons, by R. H. Rogers, Gen. Elec. Co. Illus. Nov. 9. Att. 80.

Adventures in Science, by E. L. Manning, Gen. Elec. Co. Demonstrated. Joint meeting with Engg. Soc. of Western Mass. and A.S.M.E. Sec. Dec. 11. Att. 3,000.

Toledo

Maintenance of Electrical Equipment, by W. E. Drager, Bunting Brass & Bronze Co.; Safety from the Inspector's Viewpoint, by Frank Lucas; Trolley Coaches or Buses, by

R. H. Dalgleish, Jr., Westinghouse Elec. & Mfg. Co. Moving pictures describing trolley coaches in Chicago and Salt Lake City. Jan. 15. Att. 75.

Lt. Alford J. Williams, Jr., aviation engr., spoke on the present situation in the Far East and the part played by aircraft. Feb. 4. Att. 700.

Toronto

Proposed Legislation for Licensing of Engineers, by H. Hellmuth, Assn. of Prof. Engrs. of Ontario. Jan. 22. Att. 104.

Utah

Microphones, by Prof. O. C. Haycock, Univ. of Utah; Symon's Crusher Installation at Garfield, by V. J. Del Duke; Unusual Meter Installations, by F. O. Weld, both of the Utah Pwr. & Lt. Co. Jan. 11. Att. 37.

Vancouver

National and International Aspects of the Gold Standard, by Prof. H. F. Angus, Univ. of British Columbia. Joint meeting with Engg. Inst. of Canada. Jan. 4. Att. 75.

Magnetic Phenomena in a Two-Phase Static Balancer, by Prof. E. G. Cullwick, Univ. of British Columbia. Feb. 1. Att. 30.

Washington

Engineering Aspects of Marine Transportation, by F. V. Smith, Gen. Elec. Co. Dinner. Jan. 12. Att. 85.

Worcester

Industrial Lighting, by Alfred Paulus, Westinghouse Lamp Co. Jan. 7. Att. 35.

Past Branch Meetings

University of Akron

Biography of Charles P. Steinmetz, by R. A. Ries, student; Modern Electric Elevators, by P. S. Bechtol, student. Jan. 13. Att. 11.

University of Arizona

Film—"The Conowingo Project." Jan. 8. Att. 42.

Electric Furnace, by J. W. Newman, student; Lightning, by T. S. Henderson, student. Jan. 15. Att. 6.

University of Arkansas

Construction and Use, Quality and Advantages of Aluminum Cables for Electrical Purposes, by C. B. Owen, The Aluminum Co. of America. Jan. 14. Att. 27.

Electric Elevators, by W. J. Pruett, student; Electric Furnaces, by R. B. Stone, student. Jan. 20. Att. 23.

University of British Columbia

Power Distribution in the British Isles, by C. E. G. Brown, student; Armature Reaction in Tap Wound D. C. Machines, by D. S. Smith, student. Films—"Hydroelectric Power" and "Oil Circuit Breakers." Jan. 11. Att. 19.

Dust Precipitation by Electricity, by J. D. Mitchell, student; Radio Broadcast Control, by W. B. Smith, student; Photoelectric Cells, by H. C. Freedman, student. Jan. 26. Att. 16.

Bucknell University

Steam Turbine Generator Sets, by W. E. Hall, student. Dec. 9. Att. 10.

Modernization of Industries, by I. Z. Hertzler, Hertzler & Zook Co. Jan. 13. Att. 36.

California Institute of Technology

Carl Hines and J. M. Gaylord, Metropolitan Water District, discussed the construction and electrical features of the Metropolitan aqueduct. Jan. 21. Att. 38.

Film—"New Dollar Liner, President Coolidge." Jan. 29. Att. 130.

University of California

The Application of X-Rays to Speech Analysis, by Prof. R. T. Holbrook. Refreshments. Jan. 28. Att. 76.

Case Sch. of App. Science

Experimenting with High Frequency Oscillators, by C. L. Harvey, student; A Thesis on the Power Factor of Condensers, by R. W. Schindler, student. Dinner. Jan. 14. Att. 21.

Catholic University of America

Electricity—Its History and Growth, by Dr. Valade. Refreshments. Jan. 13. Att. 29.

University of Cincinnati

Recent Developments in Electro-Chemistry, by Prof. E. C. Farnau. Refreshments. Jan. 20. Att. 45.

Clarkson College of Technology

Inspection trip to the Sugar Island, Hannawa Falls, Brown's Bridge, and Higley plants on the Racquette River. Oct. 26. Att. 27.

Inspection trip through the plant of the Aluminum Co. of America. Nov. 11. Att. 21.

Clemson Agricultural College

X-Rays and Their Applications, by H. L. Wyant, student; Electrification of the Airship Akron, by W. F. Tribble, student; Practises Used by the American Cast Iron Pipe Co., by W. M. Thames, student; Inspection of Boilers by X-Rays, by L. C. Black, student. Jan. 28. Att. 15.

Colorado Agricultural College

Films—"Life of Edison and Invention of Incandescent Lamp," and "Edison Visits General Electric Mazda Plant and Research Laboratories." Jan. 11. Att. 22.

University of Colorado

Discussion. Jan. 13. Att. 33.

The Teletypewriter, by Mr. Carr, Bell Tel. Co. Demonstrated. Jan. 27. Att. 106.

University of Denver

Business meeting. Jan. 18. Att. 13.

Film—"The Single Ridge," Feb. 2. Att. 55.

Inspection trip through the Amer. Tel. & Tel. Co. bldg. Feb. 5. Att. 56.

University of Detroit

Ultraviolet Radiation, by Mr. Garwood, Gen. Elec. Co. Films—"Vacuum Tube Synchronizing Equipment," and "Hydroelectric Power." Jan. 13. Att. 50.

The Latest Developments in Electricity, by W. A. Furst, Westinghouse Elec. & Mfg. Co. Moving pictures. Feb. 3. Att. 18.

Drexel Institute

Experiments on One-Quarter Million Volt Lightning Machine and Cathode Ray Oscillograph, by I. Eldridge, Elec. Serv. & Supply Co. Demonstrations. Jan. 20. Att. 35.

Duke University

Stanley Flack, chairman, gave a summary of the activities at the Conference on Student Activities, District No. 4, held at the Univ. of Florida. Jan. 14. Att. 23.

Stanley Flack and Mr. Debrunny, students, gave talks on radio circuits. Feb. 4. Att. 23.

University of Florida

Film—"The Single Ridge." Jan. 20. Att. 43.

Georgia School of Technology

Talk by Dr. C. E. Skinner, pres. A.I.E.E., asst. director of engg., Westinghouse Elec. & Mfg. Co. Joint meeting with A.S.M.E. Branch. Jan. 7. Att. 160.

Harvard University

Inspection trip to the short-wave and television laboratories, Boston. Jan. 12. Att. 37.

University of Illinois

Joint meeting with the Urbana Section. Papers presented by students as follows: The Electron Tube in the Modern World, by F. M. Deerhake; Electrification of Railways in India, by R. D. Varma; Television, by D. L. Pettit; The Thermocouple and Its Application to Temperature Measurements of Electrical Apparatus, by B. Figlewski. Jan. 6. Att. 31.

Iowa State College

Three Power Locomotives, by John Cross, student; The Root of Three, by Mr. Proctor, student. Jan. 20. Att. 79.

University of Iowa

Michael Faraday, by George Koval, student. Dec. 9. Att. 40.

Military Aviation, by Capt. Hide, U.S. Air Corps. Moving pictures. Dec. 16. Att. 142.

Modern Illumination, by Mr. Cleaver, Westinghouse Lamp Co. Joint meeting with A.S.M.E. Branch. Jan. 6. Att. 100.

Kansas State College

Film—"The Busy Body." Talks by four students. Dec. 17. Att. 38. Afternoon meeting. Program repeated same evening. Att. 65.

Television, by Mr. Higgenbottom. Film—"Pillars of Salt." Jan. 7. Att. 62. Program repeated same evening. Att. 40.

Lafayette College

Hydrographic Surveying, by A. M. Tomkins, student; Theory of Vacuum Tubes, by W. G. McLean, student. Jan. 21. Att. 21.

Lehigh University

Experiences on R-17 Test, by Carl W. Banks, student; Industrial Applications of Electricity, by D. M. Petty, student. Refreshments. Jan. 8. Att. 35.

Lewis Institute

Hydraulic Engineering, by G. Pfau, Allis-Chalmers Co. Illus. Jan. 22. Att. 160.

My Summer in Europe, by D. E. Dunne, student. Jan. 28. Att. 85.

Louisiana State University

Discussion. Dec. 19. Att. 22.

Economic Problems of Public Utilities, by R. M. Dreyfus, student; Rectification, by G. De La Matyr, student. Jan. 15. Att. 18.

University of Louisville

Discussion. Jan. 13. Att. 14.

University of Maine

The Business Side of the Public Utility, by R. T. Haskell, Bangor Hydroelectric Co. Jan. 14. Att. 32.

Marquette University

Demonstrations of various chemical experiments. Moving pictures. Joint meeting with A.S.M.E., A.S.C.E., and A.S.Ch.E. Branches. Dec. 10. Att. 250.

Discussion. Jan. 7. Att. 20.

Michigan Col. of Mining and Technology

The Life of Charles P. Steinmetz, by F. J. Komerska; Electrochemistry, by Prof. C. M. Carson. Jan. 14. Att. 22.

Electricity in Mining Engineering, by Prof. C. H. Baxter. Film—"King of the Rails." Jan. 28. Att. 25.

Michigan State College

Discussion. Feb. 2. Att. 16.

University of Michigan

Railroad Electrification, by H. L. Andrews, Gen. Elec. Co. Jan. 19. Att. 98.

School of Engineering of Milwaukee

The Newer Developments in the Telephone Industry, by George French, Wisconsin Tel. Co. Illus. Jan. 14. Att. 248.

University of Minnesota

Electrical Radiation Energy as Applied in Medical Practise, by Paul Luckenback, Gen. Elec. Co. Illus. General Electric Student Shop Course, by F. Suhr. Films—"Automatic Substations," and "Electric Trolley Buses." Jan. 21. Att. 95.

Missouri School of Mines and Metallurgy

Short talks by eight students. Jan. 14. Att. 9.

Electrical Construction Practise, by Wm. B. Fisher, Union Elec. Lt. & Pwr. Co. Jan. 27. Att. 40.

University of Missouri

Atoms and Electrons, by Dr. H. D. Arnold, Bell Tel. Labs. Inc. Joint meeting with Sigma Xi. Nov. 11. Att. 153.

Principles Governing the Action of the Photoelectric Cell, by N. R. Beers, student; Commercial Uses of the Photoelectric Cell, by De Laporte Johnson, student. Dec. 16. Att. 26.

Prospecting by Radio, by C. L. Lewis and A. E. Coffman, students. Jan. 13. Att. 20.

University of Montana

Papers by students: A New Warning Beacon, taken from *Electric Journal*, presented by Lewis Ambrose; Electrical South, by H. Archibald; Frequency Converter Sets Installed Outdoors, taken from *Electrical World*, presented by Harry Beck; Helical Grooves in Slip-Rings and Commutators, taken from Electrical Engineering, presented by E. Blanchard; Water Power Resources of Montana, by Arthur Buckley. Jan. 7. Att. 104.

A Weather Station on Wheels, taken from *Tycos*, presented by Edgar Dolum; The Milwaukee Electrical Shops, taken from *Electric Traction*, presented by Leonard Estey; Communication in the New Waldorf-Astoria, by Edward Fisher; Nerve Injuries from Electric Shocks, taken from Electrical Engineering, by Wesley Funk; Arc Welding Aluminum, by Vern Hankins; Telephone Apparatus for the Hard of Hearing, taken from *Bell Laboratory Record*, presented by Curtis Hanson. Jan. 14. Att. 100.

University of Nebraska

What an Engineering Student Should Get Out of a College Course, by Dean O. J. Ferguson. Election of officers: Walter M. Ely, chairman; John Hutchings, vice-chairman; A. L. Coffin, secy.-treas. Dinner. Jan. 13. Att. 35.

Inspection trip through the Northwestern Bell Tel. Co. bldg. Feb. 3. Att. 32.

Newark College of Engineering

Magnetic Testing, by Mr. Morningstern, Western Elec. Co.; Oil Filled Cables, by I. Mirkin, student. Jan. 25. Att. 18.

College of the City of New York

Election of officers: Robert G. Herzog, chairman; John Ragazzini, secretary; Jean Marcus, vice-chairman; Charles Grossfeld, treas. Jan. 7. Att. 16.

The Electron Tube—A New Tool for the Electrical Engineer, by O. H. Caldwell, editor *Electronics*. Illus. Feb. 11. Att. 84.

New York University

A-C. Arc Welding, by L. S. Lindorf, student; Thyratron Tubes, by G. M. Heckel, student. Feb. 9. Att. 13.

North Carolina State College

Smoker and discussion of Branch problems. Jan. 12. Att. 42.

University of North Carolina

The Field for Electrical Engineers, by Prof. W. J. Miller. Jan. 14. Att. 25.

North Dakota State College

Iron Ore Mining, by James Samways, student. Film—"Arteries of Industry." Jan. 27. Att. 40.

University of North Dakota

Fifty-Kw. Transmitter of WTIC, by Wm. Denk, student; Speed Torque Curves of Induction Motors, by A. Eynon, student. Jan. 13. Att. 15.

Mercury Arc Rectifiers, by Leland Hauck, student. Luncheon. Jan. 20. Att. 15.

The Mathematical Development of Fourier's Theory, by Prof. H. F. Rice, counselor. Election of officers: A. J. Redmann, chairman; C. R. Moore, vice-chairman; G. I. Anderson, secy.-treas. Feb. 3. Att. 15.

Northeastern University

Lightning, by Prof. C. L. Dawes, Harvard Univ. Refreshments. Jan. 13. Att. 112.

University of Notre Dame

Mathematics as Taught in German Universities and Secondary Schools, by Prof. P. G. Menge; Illumination, by Joseph Bean, student; The Robot, Our Electrical Superman, by Wm. Fromm, Jr., student; Life and Achievements of Thomas Edison, by John Scanlon, student. Illus. Dec. 14. Att. 52.

Weather and Climate, by Prof. D. Hull; Electrification of Coal Mines, by A. Neal, student; Electrification of Railroads, by A. Hiegel, student. John Scanlon presented the engg. digest. Jan. 18. Att. 62.

Ohio Northern University

Various Types of Electric Railways and Costs of Construction, by Donald Highlands, student. Nov. 19. Att. 20.

Ohio State University

Non-Technical Aspects in Engineering, by Mr. Bibber. Charles B. Sloan elected chairman. Jan. 14. Att. 28.

Oklahoma A. & M. College

Store and Show Window Lighting, by T. Hutchinson, student. Jan. 11. Att. 24.

University of Oklahoma

Noise Induction, by E. V. Jennings, Bell Tel. Co. and C. E. Bathe, Okla. Gas & Elec. Co. Jan. 13. Att. 98.

Oregon State College

Development and Application of Loading Coils to Telephone Circuits, by E. MacCracken, student; Choosing a Communication System for a Power Co., by J. B. Manning, student. Jan. 18. Att. 42.

Development and Use of the Vacuum Tube Voltmeter, by K. Eldredge, student. W. Hynes, student, described his summer work on the Ariel Dam. Feb. 3. Att. 21.

Pennsylvania State College

Grinding of Quartz Crystals for Use in Radio Work, by P. G. Cooper, student. Talk by R. K. McClintock, student. Jan. 13. Att. 29.

University of Pittsburgh

Mr. Hays, Westinghouse Elec. & Mfg. Co., described his travels through Central and South America. Dec. 1. Att. 87.

Electrolytic Condensers, by E. S. Drobick, student; Modern Aspects of Rigid Airships, by K. Hartwig, student. Dec. 3. Att. 124.

History of the Telephone and Toll System, by J. A. Cadwallader, Bell Tel. Co. of Pa. Dec. 10. Att. 122.

Discrepancies in Our Electrical Units, by H. E. Evans, student; Nela Park Works, Gen. Elec. Co., by F. E. Sauerburger, student. Jan. 7. Att. 123.

Pratt Institute

Constructional Details of Electric Meters, by A. R. Warrell, student; Oscillations in Vacuum Tubes, by H. Harrison, student. Jan. 11. Att. 28.

Purdue University

Surge Generators, by T. T. Woodson, student; Radio Broadcasts, by R. R. Brunner, student. Nov. 3. Att. 64.

The Thyratron Tube, by Dr. Nottingham, M.I.T. Nov. 24. Att. 250.

Film—"The Single Ridge." Dec. 8. Att. 33.

Rhode Island State College

M. J. Carr, student, gave a résumé of the principal engineering developments during the past year. Jan. 21. Att. 12.

Construction and Purpose of the Poulsen Arc, by Messrs. Porter and Andrews, students; Theory and Application of the Non-Linear Circuit, by Leon Breault, student. Jan. 28. Att. 28.

Rose Polytechnic Institute

Oil Electric Locomotives, by J. T. Jones, student; Hydrogen, a Cooling Medium for Large Machines, by C. N. McGillivray, student; Dibutyl Phthalate, by J. Neimi and J. Montgomery, students. Jan. 13. Att. 36.

University of Santa Clara

Film—"Rubber." Joint meeting with A.S.M.E. Branch. Jan. 13. Att. 100.

Recent Developments in the Field of Electrical Engineering, by W. C. Smith, Gen. Elec. Co. Joint meeting with A.S.M.E. Branch. Jan. 21. Att. 93.

The Sunnyvale Airbase, by Wendell Thomas. Joint meeting with A.S.M.E. Branch. Jan. 28. Att. 87.

University of South Carolina

Business meeting. Jan. 11. Att. 14.

Boulder Dam, by H. G. Smith, student; Construction of Voltage Divider, by J. A. Kaigler, student. Jan. 14. Att. 34.

South Dakota State School of Mines

Annual frolic. Jan. 15. Att. 65.

University of Southern California

Discussion. Jan. 6. Att. 18.

Business meeting. Jan. 13. Att. 16.

Election of officers: M. C. Marshall, chairman; L. H. Bayha, vice-chairman; R. R. Moore, secy.; M. B. Gentillon, treas. Jan. 20. Att. 18.

Stevens Institute of Technology

Future Possibilities of the Diesel Engine, by Prof. E. H. Fezandie. Jan. 15. Att. 46.

Syracuse University

Frequency Converters, by O. H. Peters, student; Keokuk Hydroelectric Development, by M. Collins, student. Jan. 8. Att. 21.

Oil Filled Cables, by A. B. Rowley and L. M. Keenan, students. Jan. 15. Att. 21.

Harmonics in Transformers, by H. Francis, student; Automatic Pilot, by Wm. Bangs, student. Jan. 22. Att. 21.

Texas A. & M. College

A Study of the Peculiarities of Telephone Rates, by J. W. Bouton, student; Designs of a Vacuum Tube Voltmeter, by C. C. Nash, student; Potential Instrument Transformers, by C. W. Bruns, student; Instrument Current Transformers, by R. L. Suggs, student; Steam Turbines in Power Generation, by O. T. Halliday, student; Auto-Transformers, by J. E. Hurley, student. Jan. 14. Att. 50.

Texas Technological College

Gaseous Tube Lighting, by C. T. Hatchett, student; Service and Service Organization of Large Communication Companies, by Evans Riley, student. Jan. 13. Att. 12.

Prof. L. S. Grandy elected counselor for the remainder of the year ending July 31.

University of Texas

Radio Airway Beacons, by Prof. R. Cranberry. Election of officers: Herman F. Barsun, chairman; E. Neuenschwander, vice-pres.; Wm. Garrett, secy.-treas.; Lowell Baker, corresponding secy. Jan. 14. Att. 25.

University of Utah

Football and Other Athletics in Their Relation to Life, by I. J. Armstrong. Jan. 14. Att. 57.

University of Vermont

Prof. L. P. Dickinson, counselor, gave a description of the winter convention of the Institute. Feb. 1. Att. 20.

Virginia Military Institute

Tests in the Westinghouse Laboratory, by C. W. Horseman, student; Transportation on Land, Sea, and Air, by W. B. Gibbs, student; The Gain in Flight Safety, by H. L. Woodson, student; Electricity in Modern Medicine, by J. T. Brugh, student. Feb. 9. Att. 52.

Virginia Polytechnic Institute

Examination and Certification of Engineers, by E. E. Barnard. Jan. 28. Att. 176.

Electric Drive for Power Plant Auxiliaries, by L. H. Morris, student; The Weather Report Instruments of the Akron, by W. H. Johnson, student. Feb. 4. Att. 42.

University of Virginia

Beauharnois Harnesses St. Lawrence for 2,000,000 H.P., by G. K. Carter, student; The Electrical Equipment Installed in the U.S.S. Akron, by R. W. Talley, student. Jan. 22. Att. 13.

University of Washington

Telephone Transmission, by J. R. Tolmie, Pacific Tel. & Tel. Co. Illus. Jan. 7. Att. 27.

Television, by T. M. Libby, Pacific Tel. & Tel. Co. Jan. 14. Att. 38.

Film—"Evolution of Power." Jan. 28. Att. 30.

Worcester Polytechnic Institute

Discussion. Jan. 25. Att. 25.

University of Wyoming

Electric Welding, by F. Wegher, student. Jan. 12. Att. 10.

Modern Telephone Practise, by L. R. Probst, Mountain States Tel. & Tel. Co. Neil H. Sanders, pres.; F. W. Wegher, vice-pres.; E. Cogswell, secy.-treas. Feb. 2. Att. 12.

Addresses Wanted

A list of members whose mail has been returned by the postal authorities is given below, with the address as it now appears on the Institute records. Any member knowing of corrections to these addresses will kindly communicate them at once to the office of the secretary at 33 West 39th St., New York, N. Y.

Araldsen, O., Westinghouse Club, Wilkinsburg, Pa.
Beck, B.O., 6165 Winthrop Ave., Chicago, Ill.
Berry, Wayne J., c/o Genl. Elec. Co., Schenectady, N.Y.
Bugg, Vernon, 736 Transportation Bldg., Washington, D.C.
Fay, John L., Genl. Del., Philadelphia, Pa.
Goldsman, Jacob L., 64 Priory Rd., Hampstead, London, Eng.
Keilien, S., 52 St. Francis St., Medford, Mass.
Kirby, F.M., 369 Lexington Ave., New York, N.Y.
Palit, Hari-Charan, 151 Ganesh Mohal, Benares City, India.
Rogge, C.A., Consumers Pwr. Bldg., Jackson, Mich.
Shapiro, Max, 757 Franklin Ave., Wilkinsburg, Pa.
Thomas, Earl Mead, Intl. Genl. Elec. Co., Schenectady, N.Y.
Titland, Trygve T., 1019 Stanton Ave., Elizabeth, N.J.
Van Der Dussen, John, 114 Gotham Ave., Gerrittsen Beach, B'klyn, N.Y.

Employment Notes

Of the Engineering Societies Employment Service

Men Available

Junior Engineers

E.E. GRAD. 1931, 24, single. 4 yr. experience in machine shop, foundry, and assembly dept. 1 yr. drafting for industrial concern. Desires position with mfg. concern or utility company. Available at once. Location, immaterial. D-311.

DISTRIBUTION ENGR., E.E. Grad. 1931, 20. Mich. State Col., single. 4 months' experience as distribution engr. for utility. Ambitious, hard worker, not afraid of responsibility. Best of references, available at once. D-323.

E.E. GRAD., cooperative college, single, 23, Protestant. Considerable machine shop and construction experience, automotive practise; 2 yr. in G.E. test course, control equip. Seeking opportunity in engg. design and development. Location and salary secondary to opportunity. Available short notice. D-36.

E.E. GRAD. 1931, 22, single, Penn. State Col., available on reasonable notice. 1 yr. experience with silk-mill equipment, 3 months in transmission dept. of utility, 2 semesters motor tests in college. Desires position with utility, engg. or mfg. company. Location, U.S., East preferred. C-9850.

E.E. GRAD. 1928, 25, single. 2½ yr. grad. study. Some experience in geophysical exploration. Available now. Location, immaterial. D-359.

YOUNG ENGR. with exceptional experience, B.S. 1928, M.S. 1930 from Worcester P.I., single, 25. 2 yr. as high voltage research asst. to recent A.I.E.E. pres. 18 months as transformer design engr. for Westinghouse. Will prove valuable to mfr., utility, or construction firm. Location, immaterial. Available now. D-319.

E.E. GRAD. Experience on multiple-unit cars. 18 months G.E. test. Automatic switchboards, motors and generators, power transformers, mercury arc rectifiers. Asst. head of rectifier test. Desires position with pwr., mfg. or ry. company. D-357.

E.E. GRAD., 1929, single, 23. 15 months as student engr. on G.E. test. Some test, drafting, and switchboard construction experience before graduation. Interested in position with a firm doing consulting or construction work or with utility or mfr. Available at once. Location anywhere in U.S., New Eng. preferred. C-8028.

E.E. GRAD., 1931, Clemson Agri. Col., 25, single. Desires work with utility, mfg. concern or construction corporation. Available immediately. Location, immaterial. D-400.

RECENT GRAD., '28, lab. experience including motor and generator design and research, drafting, oscillograph operation, breakdown and iron core-loss tests. Experience in testing industrial control equip. and telephone equip. Available, immediately. C-6611.

E.E. GRAD., 1930, 23, single. 15 months on G.E. test of railway equipment, rectifiers, industrial apparatus, industrial control, and refrigeration development. Desires position with utility or mfg. concern. Available at once. D-409.

E.E. GRAD., 1929, 23, single. M.S. from M.I.T., 1931: 20 months G.E. test course. At present teaching in E.E. dept. of leading tech. col. Desires instructorship in E.E. Available in June. Location, immaterial. C-9462.

E.E. GRAD., 1929, 25, single. M.S. '31 from M.I.T. 1 yr. G.E. test; 4 summers gen. maintenance work with telephone company. Available at once. Will go anywhere, to any position for which qualified. Salary secondary. D-175.

E.E. GRAD., 1930, 25 years of age, G.E. test experience, and about 2 yr. of wiring and repair work. Salary second to a position. Location, immaterial. D-433.

E.E. GRAD., Purdue, 1931, single, 24. 7 months in training course of a large utility company. Experienced in stenographic and secretarial work. Desires position with a future in mfg. concern or utility company. Available at once. Location, immaterial. D-437.

1931 E.E. GRAD., 23, single. High scholastic record (Tau Beta Pi). Type of work and salary secondary. Will go anywhere. Available at once. D-438.

E.E. GRAD., 1931, Worcester P.I., 22, single, member Sigma Xi, desires connection with utility concern, industry, or with teaching, also interested in drafting. Location, immaterial. Available at once. D-228.

E.E. GRAD., 1930, Georgia Tech. cooperative plan. Westinghouse lighting courses. Cooperative work, alternate months, 5 yr. large power company in substation maintenance and office engg. Thorough experience, equip. of utility and industrial customers. Now employed installing and servicing automatic stokers, heat controls, etc. Excellent references. Perfect health. Location, immaterial. C-7847.

E.E. GRAD., 1931, M.I.T. American, 25, single. Desires position with mfg. or utility company. Business environment qualifies him for sales work also. Eastern states preferred, but not essential. Available immediately. D-110.

1931 E.E. GRAD., Lehigh Univ., 23, single. Summer experience in test dept. of utility. Location, immaterial. Available immediately. D-447.

1931 E.E. GRAD., Lehigh Univ., 23, single. 12 months' experience with utility in construction. Ambitious and reliable. Available now for position of any elec. nature. Location, immaterial. D-451.

Construction

ASSOC. E.E., 34, married, technical education, desires position with utility. Exceptional ability in underground transmission and distribution systems. 1 yr. central station construction experience. Location, immaterial. Available on short notice. D-278.

Design and Development

ELEC. AND MECH. DESIGN ENGR., 37, married. Pratt Inst. night sch. grad. I.E. course. 12 yr. experience design of generating and substations; industrial layout of factories, warehouses and offices. Practical experience on maintenance of elec. equip. Available at once. C-7979.

PORTABLE TOOL ENGR. 14 yr. experience. Until merger chief engr. second largest company. Expert on universal motor design. Inventive ability combined with exec. and business judgment. D-404.

DESIGNING ENGR., E.E. GRAD., 34, married, 8½ yr. experience in design and selling of high tension outdoor substation, indoor and outdoor switching equip., bus supports and connector fittings. Desires employment with utility or mfg. concern, selling or engg., best references. D-389.

E.E. GRAD., 12 yr. comprehensive experience in designing, drafting and engg. of steam and hydroelectric plants, substations and industrial plants. Conduit plans, wiring diagrams. Available at once. D-411.

M.E. AND E.E. FORMER CORNELL INSTRUCTOR IN MACHINE DESIGN for 4 yr. Allis-Chalmers designer and checker, 5 yr. shop apprenticeship and miscellaneous experience, 32, single. Desires teaching or engg. opportunity. Salary open. D-122.

E.E., 14 yr. in field designing, drafting, testing, patent drafting and layout of elec. lt. and pwr. for bldgs. Available now. C-1095.

E.E. GRAD., 39, single. 11 yr. experience in developing, design and mfg. of small apparatus in the elec. measuring instrument line. Bridges for high and low voltage, pwr. to carrier frequencies. Exceptional theoretical training. Desires connection with high grade firm, eventually as sales engr. where exceptional tech. knowledge required. B-8131.

Draftsmen

DRAFTSMAN AND INSTRUMENT MAN, 25, single, 2 yr. univ. training, 4 yr. experience on pwr. transmission lines, telephone work, and water resources. Available now. Will go anywhere. C-7118.

ME. E.E. AND C.E. GRAD., Italy, 30, single. Has first American citizenship papers. Desires position anywhere with utility or contractor. 3 yr. varied civil engg., 2 yr. in pwr. production, in steam and hydroelectric plants. Skilled in any layout and topographic work. D-422.

Executives

EXEC. MATERIAL. Young man, solid foundation in apprenticeship training, followed by engg. and business training, substantial industrial experience, record of accomplishment, integrity, reliability; creative executive ability, desires opportunity to develop as executive material in progressive mfg. organization. C-8775.

E.E. GRAD., 48. 26 yr. experience as designing, pwr., report and exec. engr., with 3 engg. firms, on industrial and utility properties. Experience covers cost of plants, operating economics, system planning, construction supervision and appraisal of properties for various purposes. B-4553.

E.E. GRAD., Univ. of Wis., 33, single. 3 yr. Westinghouse test. 7 yr. supervising pwr. plant, substation, transmission line construction. 8 yr. engg. inspector purchasing, expediting, writing specifications, resident engr., supervising construction. Excellent reference. Can handle responsibility. Desires connection with holding company, utility or mfr. Available immediately. Location, immaterial. B-9661.

E.E. GRAD., 32, single, additional work M.E., Phi Kappa Phi. 8 yr. broad experience, pwr. house, substation, transmission line, duct system design; estimates, standards, equip. specif., operation. Responsible, capable engr. asst. Desires position with mfr. or in plant mgmt. for util. Salary secondary to opportunity. D-124.

E.E., 44, married. 20 yr. with leading cons. engr., utilities, and mfg. concerns. Experience includes responsibility for design, construction, maintenance and operation of power plants and industrial installations. Competent to supervise elec. design, construction, or maintenance. Perfect health, capable, energetic and adaptable. Available immediately. B-9194.

ANALYST of unusual ability, 44, internationally known, 22 yr. experience applying mathematical and engg. knowledge to analysis of existing records of sales, production, qualities of product, etc., to demonstrate additional sales opportunities. Improvements of mfg. and sales policies and more profits followed analyses. Available short notice. Location, immaterial. D-340.

E.E. seeks position in operating dept. of utility or as industrial plant engr. Married. Tech. grad. Factory test floor experience. 17 yr. varied experience with utility and industrial plants. Speaks Spanish fluently. Location, immaterial. Further information on request. Available on short notice. A-4018.

EXEC. ASST. OR EDITOR, Cornell E.E. Grad. 10 yr. asst. to vice-pres. and gen. mgr. Experienced in engg. writing with leading publications, preparation of bulletins and instruction books. Desires exec. work, writing or sales. A-1558.

E.E. GRAD., 32, single. 9 yr. of design and construction of pwr. trans. lines, substations and distribution networks as engg. inspector, purchasing, expeditor, preparing estimates and writing specifications. Excellent references. Desires connection with holding company, operating company, contractor or mfr. Available immediately. Location, immaterial. C-3564.

ELECTRICIAN OR FOREMAN, 25, single, white. 10 yr. experience in coal and metal mining transportation systems. I.C.S. grad., LaSalle Extension Univ. course in indus. mgmt., now taking E.E. course with American School. Speaks English, Slovanian, Spanish. Worked 3 yr. in S. Amer. Will travel. D-380.

E.E. GRAD., Worcester P.I., 1921, 33, married. 8 yr. experience, engg., design, purchase of equip. and construction of pwr. stations, switching stations and substations, 2 yr. in ry. work. Desires sales engg. work. Location, New York, New Jersey metropolitan preferred. Available immediately. C-9928.

EXECUTIVE, 33, E.E. and M.E. Grad. 12 yr. mfg., production, design, advertising, merchandising, accounting desires position involving major responsibilities. Exceptionally wide contact with all types plants throughout country. Characterized as an able organizer and an alert, untiring worker with vision, a highly practical profit-consciousness and quiet aggressiveness. C-1297.

GRAD. ENGR., 34, married. 12 yr. communication, distribution system construction, materials and construction methods supervising engr., cable installation, etc., for metropolitan and mgmt. utilities. Desires responsible position where practical ability, resourcefulness and good personality is required. D-44.

TRACTION ENGR., 28, single, 5 yr. experience in electric traction shops as inspector, since then and at present in charge of service of southeast on registers. 2 yr. at Georgia Tech., later E.E. grad. from I.C.S. Was radio operator. Desires position as asst. engr. for elec. traction. D-80.

E.E. GRAD. Pwr. station design and elec. distribution experience. Desires position in similar field or in research lab. Temporary position will be considered. Preferred location, metropolitan district of N. Y. or Phila. B-1923.

EXECUTIVE, E.E. GRAD., married, 30 yr. experience, mgr., supt., E.E., construction and operation, utilities. Installed steam—Diesel-hydroelectric plants. Building substations, transmission lines, distributing systems, street car network, laying underground and undersea cables. District mgr., sales representative for mfr. of H.T. oil circuit breakers, switches, transformers. Available now. B-2388.

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Membership

Applications for Election

Applications have been received by the secretary from the following candidates for election to membership in the Institute. Unless otherwise indicated, the applicant has applied for admission as an Associate. If the applicant has applied for direct admission to a grade higher than Associate, the grade follows immediately after the name. Any member objecting to the election of any of these candidates should so inform the secretary before March 31, 1932.

Abel,A.E.,Jr.,Univ.of Ill.,Urbana
Altrup,F.W.,Phil.Stor.Bat.Co.,Washington,D.C.
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Armstrong,J.H.,Univ.of Ill.,Champaign
Arndt,W.F.,1808 N.Bronson Ave.,Hollywood, Calif.
Backstrom,C.W.,Worcester Poly.Inst.,Mass.
Barber,M.H.,Southern Sierras Pwr.Co.,Riverside,Calif.
Barnwell,J.R.,U.S.Engr.Office, Florence,Ala.
Belden,C.L.,The Montana Pwr.Co.,Roundup
Bennett,F.A.,Hart Mfg.Co.,Detroit,Mich.
Bennett,J.O.,Western Elec.Co.,Inc.,Kearny,N.J.
Billette,R.,Gurney Foundry Co.,St.Laurent, Que.,Can.
Bisbee,J.M.,United Elec.Lt.& Pwr.Co., N.Y. City
Blind,K.A.,Milwaukee Elec.Rwy.& Lt.Co.,Milwaukee,Wis.
Bock,F.S.,Jr.,Shell Oil Co.,Coolidge,Ariz.
Boden,A.T.,Brooklyn (N.Y.) Edison Co.
Bookout,A.C.,(Member),Southwestern Bell Tel. Co.,Oklahoma City,Okla.
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Buckley,S.W.,Gen.Engg.Co.,Wilmington,Del.
Buge,A.,1241 South 24th St.,Milwaukee,Wis.
Bullock,N.,Panama City,Fla.
Burtis,J.H.,(Member),Westchester Co.Sanitary Comm.,White Plains,N.Y.
Calkins,E.H.,2218 Horton Ave., S.E.,Grand Rapids,Mich.
Canning,G.R.,Ohio Bell Tel.Co.,Cleveland
Carlston,J.O.,837 So.6th East,Salt Lake City, Utah
Ceserani,F.L.,Montana Pwr.Co.,Helena
Chakrabarty,M.N.,Purdue Univ.,W.Lafayette, Ind.
Chandler,J.A.,Cleveland Bd.of Education,Ohio
Church,C.A.,Univ.of Colorado,Boulder
Clark,E.B., Farrel-Birmingham Co., Ansonia, Conn.
Clemens,N.O.,Quakake,Pa.
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Conklin,C.E.,Walker,Minn.
Conroy,E.W.,(Member),Puget Sound Pwr.& Lt.Co.,Bremerton,Wash.
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Cope,D.S.,Univ.of Minnesota,Minneapolis
Curtis,R.M.,Penn.Rr.,Rahway,N.J.
Damidovich,J.F.,R.D.No.2,Aurora,Ill.
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Darlington,F.J.,Pacific Tel.& Tel.Co.,Seattle, Wash.
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delaGarza,E.,Box 304,Brownsville,Tex.
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Diggs,V.A.,The Ohio Bell Tel. Co.,Cleveland
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Miller,G.W.,Univ.of Wisconsin,Madison
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March 1932

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Number	Author	Title
□ 32-54	Edward Bennett	The Proximity Effect and Its Application to the Concentration of Heating Currents in Predetermined Strips
□ 32-55	W. C. Lallier	Toll Switching Plan for Wisconsin
□ 32-56	C. F. Harding, L. L. Carter and J. W. Olson	Weather Resistant Insulation for Line Wires
□ 32-57	E. C. Williams	Electrical Design Features of Waukegan Station
□ 32-58	R. B. Williamson	115,000-Kw. Turbo-Alternator
□ 32-59	W. L. Lloyd, Jr.	Insulator Sparkover
□ 32-60	A. O. Austin	An Improved Type of Limiting Gap for Protecting Station Apparatus
□ 32-61	J. J. Torok and C. G. Archibald	Design and Economic Selection of Suspension Insulator Assemblies
□ 32-62	H. A. Frey and K. A. Hawley	Normal Frequency Arcover Values of Insulators
□ 32-63	O. K. Marti	The Mercury Arc Rectifier Applied to A-C. Railway Electrification
□ 32M3	C. D. Brown and E. W. Hatz	The 60-Cycle Primary Transmission System of the Milwaukee Electric Railway and Light Company
□ 32M6	C. Stansbury	A General Method of Gaseous Tube Control
□ 32M7	O. M. Ward	Mercury Arc Rectifier versus Rotary Converter Automatic Railway Substations
□ 32M8	R. E. Pierce	Police Teletypewriter Communication
□ 32M9	J. L. Hecht	Development of the Waukegan Station of the Public Service Company of Northern Illinois
□ 32M10	E. X. Schmidt	Electrical Instruments in the Gas Industry

Papers presented prior to September 1931 and upon which articles in this issue are based

Number	Author	Title
□ 31-103	H. S. Fitch	The Pennsylvania-Ohio-West Virginia Interconnection
□ 31-106	A. E. Bauhan	Interconnection Services, Their Classification and Evaluation
□ 31-107	E. W. Dillard and W. R. Bell	Interconnection—New England District
□ 31-119	G. M. Keenan	Interconnection Development and Operation

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Takada,M.,Electrical Research Institute of Tokyo,Tokyo,Japan
Vijh,H.C.,Military Engr.Service, Ahmednagar Cantt.,Deccan,India
8 Foreign

Engineering Literature

New Books
In the Societies Library

AMONG the new books received at the Engineering Societies Library, New York, during January are the following which have been selected because of their possible interest to the electrical engineer. Unless otherwise specified, books listed have been presented gratis by the publishers. The Institute assumes no responsibility for statements made in the following outlines, information for which is taken from the preface or text of the book in question.

POWER PLANT MANAGEMENT. W. N. Polakov. N. Y. & Lond., McGraw-Hill Book Co., 1932. 176 p., 8x5 in., cloth, $2.00.——Outlines an efficient and economical method for organizing the human side of power-house work in various factories and power plants, including duties of various employees, methods of accounting and recording, and wages.

THOMAS A. EDISON, Benefactor of Mankind. By F. T. Miller. Chicago, Phila., Toronto, John C. Winston Co., 1931. 320 p., 9x6 in., cloth, $1.50.——A well illustrated popular life of Edison, the first since his death, with the cooperation of the family and associates of Edison. An excellent account.

RECOLLECTIONS OF EDISON. By D. T. Marshall. Boston, Christopher Publishing House, 1931. 117 p., 8x5 in., cloth, $1.75.——Dr. Marshall's contribution to Edisonana, though slight, has some interest. As a boy in Metuchen, he was familiar with the Menlo Park laboratory; in 1887 he became a chemist at the West Orange laboratory. His recollections deal with the appearance of the laboratories at that time, the men who worked in them, and their methods and activities.

SYMPOSIUM ON WELDING. American Society for Testing Materials. Phila., 1931. 151 p., 9x6 in., cloth, $1.75.——Eleven papers presented at a meeting of the society in Pittsburgh, March 1931, with discussions. Includes a general survey of processes, account of processes for welding aluminum, and papers on materials for fusion welding, modern applications of arc welding and recent developments in gas welding. Other papers discuss matters of inspection and testing in the use of the stethoscope, gamma-ray testing, magnetic testing, and fatigue and impact tests.

V D E FACHBERICHTE, 1931. Berlin, V D E—Verlag. 177 p., 12x8 in., paper, 12 RM; bound, 14 RM.——This report contains the technical papers presented at the 1931 convention of the Society of German Electrical Engineers. The theme of the meeting was long distance power transmission, discussing power generation, transmission, interconnection, power utilization, etc. Includes 62 papers.

HANDBOOK OF CHEMISTRY AND PHYSICS. By C.D. Hodgman and N.A. Lange. 16 ed. Cleveland, Ohio, Chemical Rubber Publ. Co., 1931. 1545 p., 7x4 in., cloth, $5.00.——The new edition of this popular handbook contains 180 pages more than the previous one, in addition to extensive revision throughout the book. The book continues to be an exceedingly useful reference work for the student and research worker, presenting a large collection of frequently used data in convenient form.

INTRODUCTION TO THE HISTORY OF SCIENCE. V. 2 in two parts. From Rabbi Ben Ezra to Roger Bacon. By George Sarton. Publ. for the Carnegie Institution of Washington, as Pub. No. 376, by Williams & Wilkins Co., Baltimore, 1931. 1251 p., 11x7 in., cloth, $12.00.——A masterly survey of the growth of scientific thought and achievement over the twelfth and thirteenth centuries. An inventory of mediaeval science, East and West, on a scale never before attempted, indispensable to students

INDEX TO A.S.T.M. STANDARDS AND TENTATIVE STANDARDS. Phila., American Society for Testing Materials, 1931. 103 p., 9x6 in., paper, free.——Combined index, covering all A.S.T.M. standards in effect in Sept. 1931, telling in which publication they can be found, and making it easy to determine whether a particular specification exists and where it may be found.

APPLIED GYRODYNAMICS. By E. S. Ferry. N. Y., John Wiley & Sons, 1932. 277 p., 9x6 in., cloth, $4.00.——The purpose of this work is to present gyrodynamics to the acquaintance of engineers and students having the mathematical equipment of the ordinary graduate of engineering or physics. It considers such important devices as the gyrohorizon, the gyrosextant, the gyrocompass and gyrostabilizers for ships and monorail cars.

NEW CONCEPTIONS OF MATTER. By C. G. Darwin. N. Y., Macmillan Co., 1931. 224 p., 9x6 in., cloth, $3.00.——This book, based on Prof. Darwin's Lowell Institute lectures in 1931, is a clear description of the broad features of the new mechanics in non-technical language without the use of mathematics. The book is not light reading but calls for no technical knowledge upon the part of the reader.

THEORETICAL PHYSICS. V. 1. Mechanics and Heat. Newton-Carnot. By W. Wilson. N. Y., E. P. Dutton & Co., 1931. 332 p., 9x5 in., cloth, $6.00.——Prof. Wilson's aim is to present an account of the theoretical side of physics which will be sufficiently comprehensive to be useful to students, without being too elaborate and voluminous. This volume, the first of three, deals with mechanics and heat. The subjects are developed according to their historical growth.

EINFUHRUNG IN DIE THEORIE DER SCHWACHSTROMTECHNIK. By J. Wallot. Berlin, J. Springer, 1932. 331 p., 10x7 in., paper, 21.50 RM; bound, 23 RM.——An introduction to the theory of telegraphy and telephony based upon courses given in the central laboratory of Siemens & Halske to the laboratory staff. A book on concepts and developments of weak-current theory in an easily understandable form.

DIE ELEKTRISCHEN MASCHINEN; Bd. 1. Allgemeine Grundlagen, by M. Liwschitz. 2nd edit., 381 p., 18 RM. Bd. 2. Die elektrischen Maschinen, by M. Liwschitz and H. Glöckner. 1st edit., 306 p., 19 RM. Leipzig & Berlin, B. G. Teubner, 1931. 9x6 in., cloth.——To give the young engineer an understanding of the relationship between natural laws and electrical machine behavior so as to equip him for advanced study and independent work as a designer.

Industrial Notes

Allis-Chalmers Appoints L. W. Grothaus.—Announcement has been made that L. W. Grothaus succeeds C. E. Searle as general representative of the Allis-Chalmers Manufacturing Company, Milwaukee. Mr. Searle resigned on January 31 to become vice-president of an eastern firm. Mr. Grothaus has been affiliated with the Allis-Chalmers Company since 1904. Prior to his promotion he was assistant manager of the electrical department.

American Transformer Appointments.—Announcement has been made by the American Transformer Company, Newark, N. J., of the appointment of two sales representatives. Edgar M. Moore Company, Farmers Bank Building, Pittsburgh, will handle sales of AmerTran industrial transformers in western Pennsylvania, southern Ohio, and West Virginia. Theodore F. Mueller, 3-260 General Motors Building, Detroit, will handle sales of all AmerTran products in the entire state of Michigan with the exception of the upper peninsula.

Steel Tubes Announces Appointment.—Morgan P. Ellis has been appointed vice-president in charge of all sales. Murray J. Whitfield is general sales manager of the electrical division in charge of sales of "Steeltubes" electrical metallic tubing (thin wall conduit).

General Electric Orders in 1931.—Orders received by the General Electric Company during the year 1931 amounted to $252,021,496, compared with $341,820,312 for 1930, a decrease of 26 per cent, President Gerard Swope has announced. Orders for the quarter ended December 31 amounted to $49,321,480, compared with $74,168,480 for the last quarter of 1930, a decrease of 34 per cent.

Insulator for Universal Clips.—Rubber insulators of a new and improved style are now being offered for Universal clips. These new insulators have an extended tubular portion at the rear which insures that any bending of the cord near that point takes place on a relatively large arc, thus preventing breakage of the copper conductor. A further feature of the new insulator is an interior constricted ring of rubber, which serves to keep the insulator from slipping down on the cord when the clip is applied to a terminal. An interior arrangement of the insulator makes it possible to mount it on the clip either with the nose exposed or with the clip completely enclosed, so that the nose is flush with the outer opening. This latter position is often desired, as it prevents the clips short-circuiting with each other when knocking about on the test floor, test bench or laboratory table. Mueller Electric Co., 1583 East 31st St., Cleveland.

Electrolytic Condensers for Capacitor Motors.—With considerably improved characteristics due to a radical departure in the formation of the oxide dielectric film on the aluminum foil, the small electrolytic condenser is ready to go outside the radio field and find many applications in electrical and industrial functions according to William Dubilier, pioneer condenser designer and manufacturer. "Recently, our engineers have developed a new and radical means of forming the oxide film on the electrolytic condenser foil," states Mr. Dubilier. "Not only do we obtain a tougher dielectric film, capable of higher working voltage and faster comeback in the event of a breakdown, together with a more favorable power factor, but the very nature of our new forming process conserves the electrolyte for a longer service life. We now find it possible to employ electrolytic condensers for capacitor motor functions. The 110-volt or 220-volt a-c. electrolytic units are proving satisfactory for starting and intermittent service. The fact that a very high capacity is obtainable at a very low cost, makes these capacitors highly desirable today."

A New Oil Purifier.—A new type of centrifugal oil purifier for transformer and circuit breaker oil, in which the oil is centrifugally purified under a high vacuum, has been introduced by the Sharples Specialty Company, of Philadelphia, under the registered trade name of "Deoxator." It is claimed that this machine not only removes any free air in the oil, but also removes 90% of the oxygen in solution and any dissolved moisture. The removal of the oxygen in solution tends to reduce the formation of sludge through oxidation while the removal of dissolved moisture produces a dielectric that will last longer.

The Deoxator can be used effectively for the following work: for filling and "drying out" new equipment; for filling Inertaire type transformers to eliminate second blowing with nitrogen; for centrifuging oil in transformers that are designed to prevent air contact and preventing the introduction of any air whatsoever into the transformer; purifying oil for oil filled cables; purifying oil in subway type transformers that are sealed up tight; for producing a purified oil with less sludge forming tendencies and having a more persistent dielectric. In the Deoxator the centrifuge bowl is still used to remove free water and sludge while the vacuum removes dissolved moisture and oxygen in solution. Unless the free water is removed first by the centrifuge bowl, the vacuum efficiency is destroyed by the surplus water vapor.

Trade Literature

Motors.—Bulletin 173, Part 4, 2 pp. Describes brush-riding repulsion-induction motors. Wagner Electric Corp., 6400 Plymouth Avenue, St. Louis.

Indoor Bus Supports.—Bulletin GEA-924B, 32 pp. Describes in detail various types of bus supports available to meet the requirements of various installations. General Electric Co., Schenectady, N. Y.

Aluminum Bus Bars.—Booklet, 20 pp., "Channeluminum Electrical Conductors of Alcoa Aluminum." Includes illustrations and diagrams as well as installation photographs. Aluminum Company of America, Pittsburgh, Penna.

Constant Voltage Regulators.—Bulletin 5501. Describes Ward Leonard constant wattage voltage regulators for eliminating the distortion and inaccuracies of photo-cell devices resulting from voltage fluctuation. The device is a voltage transformer and regulator combined, reducing the a-c. line voltage to that required by the exciter lamp, and maintaining the exciter lamp voltage constant regardless of instantaneous fluctuations in line voltage. The design of the regulator is such as to compensate for variations in lamps of the same nominal rating and to correct for the increase in lamp resistance due to aging. The regulators are used to maintain constant voltage with various types of loads, constant or variable, with leading or lagging power factors. Ward Leonard Electric Company, Mount Vernon, N. Y.

Thrustors.—Bulletin GEA-1262B, 24 pp. Describes G-E Thrustors for producing a straight-line, constant-pressure thrust from an electric motor drive. There are two general fields of application of these units: (1) to supply pressure and actuate lever mechanisms, (2) to replace muscular effort with electric control on foot- or hand-operated machines. The device can be installed easily on practically any type of equipment. It handles clutches and brakes in such a way as to prevent strain and excessive wear; it can be utilized to increase production; to afford greater safety for the workman, and to give complete electric control. Typical installations are illustrated on punch presses, spot welders, hoists and elevators, valves, conveyors, and for opening and closing sliding, swinging and lift doors. General Electric Company, Schenectady, N. Y.